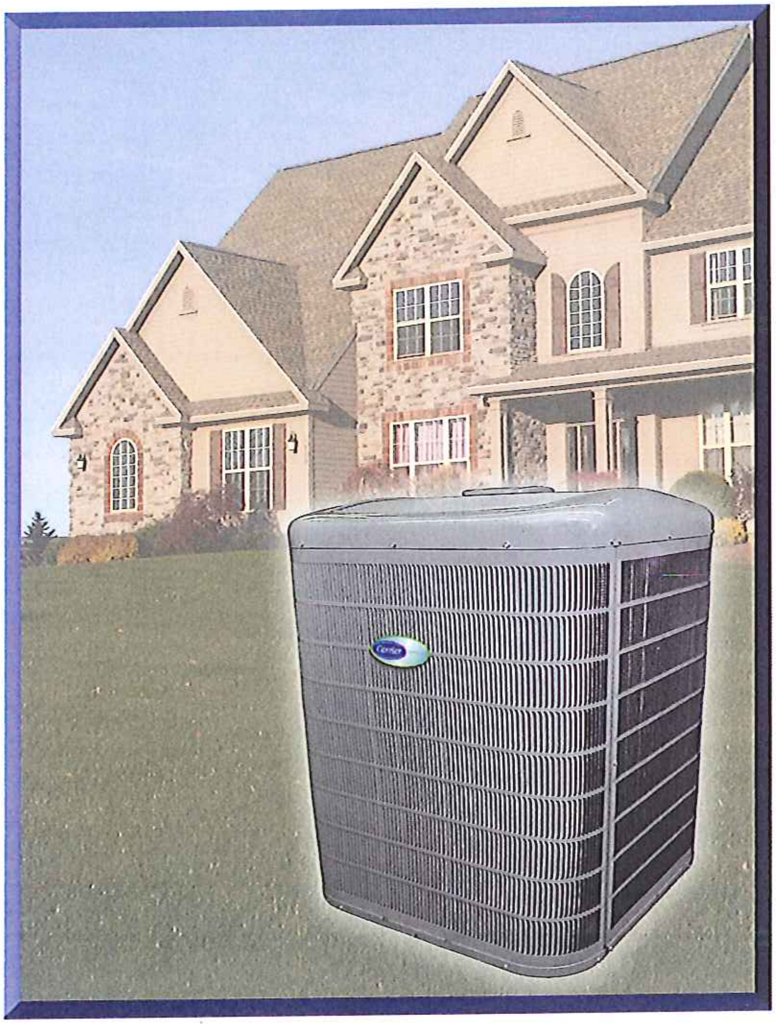
CARRIER

SERVICE

Training



24VNA9 & 25VNA8

INFINITY® COOLING & HEAT PUMP OUTDOOR UNITS

INTRODUCTION • FAMILIARIZATION • CONTROLS, SYSTEM SETUP, AND CHECKOUT • UNIT SERVICE • MAINTENANCE • TROUBLESHOOTING

Form No. 24/25VNA-01

Catalog No. 06-C24-028

Infinity® 19VS High-Efficiency Air Conditioner
and
Infinity® 18VS High-Efficiency Heat Pump

This training consists of a PowerPoint™ presentation on CD, Catalog No. 06-C24-029 and this book, Catalog No. 06-C24-028. The primary purpose of this program is to familiarize you with these products, their components and their operation so that you can install and start-up a new unit, provide service and maintenance for this unit, and troubleshoot problems. This training covers the 24VNA9 variable speed air conditioner and the 25VNA8 variable speed heat pump.

Table of Contents

Objectives

At the completion of this program the student will be able to:

1. Identify basic components of the 19VS air conditioner and 18VS heat pump.
2. Describe the operation of the inverter drive compressor and state the precautions to observe when servicing the unit.
3. Identify the proper operating sequences for cooling and heat pump operation.
4. Use the User Interface (UI) to set up the unit and read error code history.
5. Describe proper service procedures for checking, charging, and troubleshoot cooling and heat pump problems.
6. Describe proper service and troubleshooting procedures for heat pump EXV
7. Explain the operation of the variable speed outdoor fan and how to troubleshoot it.
8. Explain how to troubleshoot the variable speed compressor using the error codes.

Presentation Instructions

1. Obtain necessary audiovisual equipment, training aids, handout materials, and books for each participant.
2. To run the CD-ROM training program follow the instructions printed on the label or in the "READ ME" file. Show images section-by-section. Review, discuss and ask questions at the end of each section highlighting topics of importance.
3. Distribute and review handout materials (see suggested list of additional materials below).

Handout Materials/Additional Training Materials

1. Additional workbooks.
2. Visual aids and appropriate tools to support discussion and demonstrations.
3. Service, Installation, and Start-Up Instructions for one unit model.

Self-Instruction

When using this program for self-instruction, view the narrated PowerPoint™ or read the workbook in its entirety and complete the quiz. Quiz answers with page references are located in the back of this manual.

Introduction

- **Infinity® 19VS Air Conditioning Unit**
  - Up to 19 SEER
- **Infinity® 18VS Heat Pump Condensing Unit**
  - Up to 18 SEER, 11 HSPF
- Variable Speed Compressor and Drive
- Installation Flexibility

This service-training program introduces Carrier's Infinity® 19VS air conditioner model 24VNA9 and Infinity® 18VS high-efficiency heat pump condensing unit model 25VNA8. These units feature variable-speed rotary compressors driven by a variable-speed drive. They can use either the Infinity® Touch communicating controls for full variable speed functionality, or a standard, 2-stage or single-stage thermostat, for limited functionality. The ability to modulate the compressor speed based on the system cooling or heating load allows the unit to achieve high cooling efficiencies SEER (Seasonal Energy Efficiency Ratio) of up to 18 on the heat pump and 19 on the air conditioner. And on the heat pump achieve high heating efficiencies with an HSPF (Heating Seasonal Performance Factor) of up to 11.

These products are designed to meet the comfort needs in both for residential and light commercial applications.

Benefits

- Capacity modulates as low as 25%
- Precise load matching
- Superior zoning capability
- Superior dehumidification and zoning
- Sound as low as 55 dBA
- Small footprint
- Application flexibility

The ability to use the load on the system to modulate the compressor speed gives these exceptional heating and cooling efficiencies, as well as superior comfort, dehumidification, and low sound levels, all in a compact package. The 24VNA9 air conditioner and the 25VNA8 heat pump are the smallest ducted models on the market that use variable speed compressors.

These systems are designed to provide flexibility for dealers and their customers. If initial cost is an issue in a retrofit situation, a phased-in installation approach can be used. The variable-speed outdoor unit can be installed with an existing indoor unit of the appropriate size and a conventional thermostat for limited functionality. This allows the dealer to use a phased-in retrofit approach when it is not feasible to change out a complete system. The indoor unit and control system can be replaced later to achieve full system functionality.

The 24VNA9 air conditioners and 25VNA8 heat pumps are simple to install. They require only line sets to the indoor coil and single-phase 208/230V electrical power. When installing a complete Infinity® system with an Infinity® Touch control, only two communication wires to the outdoor unit are needed to obtain full system operation. The Infinity® Touch user interface (UI) simplifies system operation. Servicing is also made simple through the service menus in the UI.

Overview

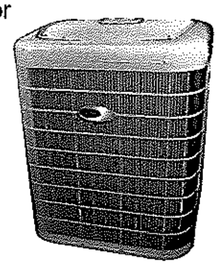
- Familiarization
- Controls and Hardware
- Unit Operation
- Start-Up
- Service and Maintenance
- Troubleshooting

In this program, you will become familiar with the components within the air conditioning and heat pump units. You will take an in-depth look at the controls and controls hardware specific to the operation of each of these units and will learn the unit operation. You will go through a checklist of start-up procedures and learn some service and maintenance procedures that should be performed on these products. In turn, this will allow you to troubleshoot the unit when necessary.

At the completion of this training program you will be able to conduct the initial start-up of these products, understand the basic operation of the products, provide the maintenance and service to the products, and perform troubleshooting.

Variable-Speed Capability

24VNA9 Air Conditioning Unit

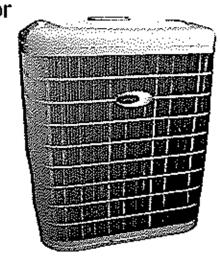


- Variable speed rotary compressor and inverter control
- 5 stages of operation
- Compact ECM variable speed fan motor
- 2-Wire to outdoor unit in Fully Communicating System including Infinity® Touch Control

These air conditioner and heat pump products feature a smaller and lighter cabinet, efficient and quiet rotary compressors, and compact ECM fan motors (brushless DC) (BLDC) that contribute to a high-efficiency unit in a compact package. The unit is designed to operate at five capacity stages in a fully communicating system. The compressor stage will depend on the outdoor temperature and system demand. This unit is also designed to work as a two-stage unit when using a 2-stage indoor unit and 2-stage thermostat, or a 1-stage unit when using a 1-stage indoor unit and thermostat. The compressor is driven by a variable-speed drive (VSD), also known as an inverter. A thermostatic expansion valve (TXV) is the metering device used for the cooling mode. In the heat pump an electronic expansion valve (EXV) metering device is used in the outdoor coil for the heating mode. A new pressure equalizer valve (PEV) is used to ensure easy starting of the rotary compressor. Pressure and temperature sensors are strategically placed and are constantly monitored to ensure that the system operates within safe and reliable limits.

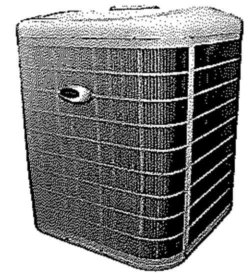
The system provides a wide capacity range from 100% to as low as 25% for enhanced comfort, precision humidity control and superior zoning capability.

25VNA8 Heat Pump Condensing Unit



- Variable speed rotary compressor and inverter control
- 5 stages of operation
- Compact ECM variable speed fan motor
- Electronic Expansion Valve for heating
- 2-Wire to outdoor unit in Fully Communicating System including Infinity® Touch Control

Electrical, Cooling, Heating Capacity Offerings

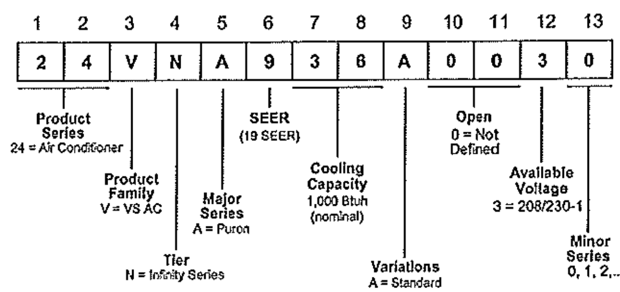


- ELECTRICAL POWER: 208-230/1/60
- COOLING AND HEATING CAPACITIES: 2 to 5-Tons Nominal Capacities

These units operate on readily available 208/230-volt, single phase power and have cooling capacities of 2, 3, 4 and 5 tons (nominal 24,000, 36,000, 48,000, 60,000 Btuh) to meet most residential and light commercial applications.

AC Model Numbers

AC Model Nomenclature

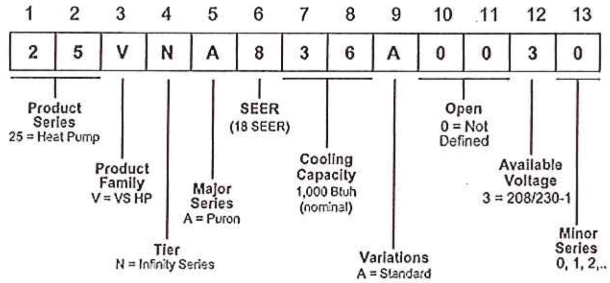


The model number contains 13 significant digits. It is very important that all 13 digits of the model number are used to identify the construction of the product that is being serviced or when parts are being ordered. The model number should only be recorded from the unit informative data plate. If the entire model number is not used, there is a risk that incorrect information or incorrect parts may be provided.

The number 24 in the model number indicates that this is an air conditioning condensing unit and the V that it is a variable speed unit. The fifth digit indicates the unit use Puron refrigerant. While the sixth digit indicates the unit is a 19 SEER (Seasonal Energy Efficiency Ratio). The seventh and eight digits indicate the capacity of the unit which in this case is 36,000 Btuh. Finally the number 3 in the 12 digit indicates that unit runs on 208/230 single phase 60 HZ power.

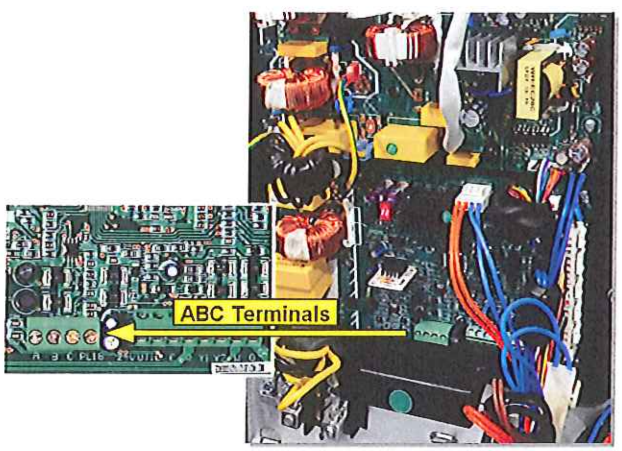
HP Model Numbers

HP Model Nomenclature



Like the air conditioner the heat pump model number has 13 significant digits. The number 25 in the model number indicates that this is a heat pump. Other digits in the model number have the same significance as with the air conditioner model numbers. However the heat pump is an 18 SEER rating. The model numbers do not directly indicate the heating capacity or HSPF.

Unit Overview



Both the 24VNA9 and the 25VNA8 units have a single row wrap-around outdoor coil. The outdoor fan draws air through the coil and discharges it vertically through the top fan guard. Single-phase primary power is brought into the units from a field-installed disconnect wired to the terminal block. The terminal block is located below the compressor variable speed drive. The ground wire is secured to the ground lug mounted on the back of the control box. Two-wire communication wiring is brought into the unit from the A and B terminals on the indoor unit board to the A and B terminals of the outdoor unit (AOC) board. However, it is always good practice during installation to run extra communication wires so that if one wire breaks, an extra wire is available as a replacement. Since the outdoor unit has its own 24-volt power supply, the C and D power does not have to be provided by the indoor unit.

On some older indoor units, it may be necessary to run a wire between the indoor unit and the outdoor unit common C terminals of the ABCD connector. The reason is that when the new unit is installed with an existing indoor unit, the ground wire of the existing unit and the ground wire of the new unit may have a different resistance to earth ground. If the resistance to earth between the two units is close and falls within a window or a range, the communicating control recognizes it as a common ground. If the resistance to earth between the two units is outside of this window or range, the two units are not recognized by the communicating control to be together in the system. An indication of this is that the communicating control will not be able to find the outdoor unit even though wires at A and B are connected correctly. If this occurs, connect a wire between the C terminals of both the indoor and outdoor units. This is another good reason to run additional communication wires during the initial installation.

Safety

Improper installation, adjustments, alterations, service, maintenance, or use can cause explosion, fire, electrical shock, or other conditions that may cause death, personal injury or property damage. Follow all safety codes. Wear safety glasses, protective clothing and work gloves. Warning labels are displayed prominently on panels of the units to provide the service technician with the information needed to prevent accidents. Warnings are also printed in the Installation Instructions and service manuals available for these products. On all units, labels alert the technician that the variable-speed drive contains charged capacitors that must be allowed to discharge for at least 2 minutes before performing service on the variable-speed drive.

Systems containing Puron® refrigerant operate at higher pressures than old R-22 systems. Do not use R-22 service equipment or components on Puron systems. Read and understand all warning labels that are attached to the outer panels, as well as any warning labels located on the inner panels of these units.

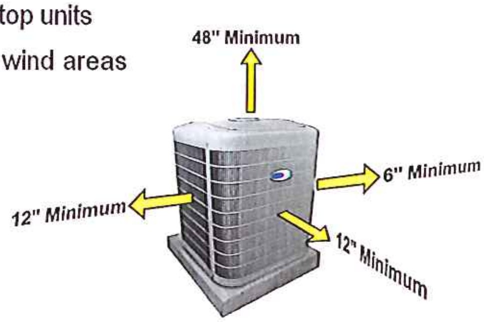
Failure to read or understand these warnings could result in damage to the products, and injury or even death to the service technician. If you do not understand any of the warnings, contact your product distributor for better interpretation of the warnings.

Before installing, modifying or servicing these systems turn the main electrical disconnect switch to the OFF position, lock the electrical disconnect switch in the OFF position and install a tag with an approved warning label. And remember, there may be more than one disconnect switch for the system.

Installation

Wind baffles may be required for:

- Rooftop units
- High wind areas



The installation of the unit must allow enough clearances for proper operation, wiring, piping and service to the unit. For service, allow for 24 inches at the end of the unit. For proper airflow, a 6-inch clearance on one side of the unit and 12 inches on all remaining sides must be maintained. Allow 48 inches clearance above the unit for proper airflow. Units should be positioned so that water, snow or ice from roof eaves cannot fall directly on them. On applications where multiple units are installed, maintain a minimum of 24 inches between units.

For rooftop applications, mount the unit on a level platform or frame. Position the unit above a load-bearing wall and isolate the unit and the refrigeration piping from the structure of the building. The supporting members should be arranged adequately to support the unit and minimize transmission of vibration into the building. Rooftop applications require that the unit be located at least 6 inches above the roof surface.

For hurricane tie-downs, contact your distributor for details and professional engineering certification, if required. All units must be level to within plus or minus 2 degrees, which equates to plus or minus 3/8-inch per linear foot.

Heat Pump Installation

Wind baffles may be required for:

- Rooftop units
- High wind areas
- Aiding in defrost
  - Prevents the water from refreezing to the coil during the defrost mode

In geographical areas that experience prolonged subfreezing temperatures, the heat pump should be installed on risers so that the unit is above the buildup of ice that occurs during defrosting cycles.

If conditions or local codes require that the unit be attached to a pad, tie-down bolts should be used and fastened through knockouts in the unit's base pan.

In high-wind areas, roof-mounted units should use wind baffles. Wind baffles should also be used in high wind areas to prevent re-freezing of the moisture on the coil in the defrost mode.

Unit Sizing Considerations

COOLING LOAD (TONS)	EQUIPMENT SIZE FOR HEATING
2.5	36,000
3	48,000
3.5	60,000
4	60,000
5	60,000

For air conditioning units a load estimate should be performed and the units sized the same as with other single or dual-speed units.

When selecting and sizing heat pump equipment for an application, consideration should be given to whether the load in the conditioned space is primarily a cooling load or a heating load.

If the primary load is cooling, size the equipment the same as it would be sized for a typical single- or dual-speed air conditioning system. If the application is primarily a heating load, equipment can be sized to take advantage of additional heating capacity using the chart shown. Typically, if the equipment is sized for a primary heating load it results in equipment that is oversized for the cooling load. However, both the compressor and indoor fan are variable speed, so the system will operate to match the load, and is thus less sensitive to typical oversizing drawbacks.

Note that the indoor fan, outdoor fan and compressor are variable-speed devices. They change speed according to ambient conditions and space conditioning needs. It is important to make sure that both the maximum and minimum airflows can be handled by the ductwork in the conditioned building. If there is a concern that ductwork is marginally sized for the maximum airflow, alternate settings can be selected using the Infinity® Touch control to limit the maximum system operational stage in heating and cooling separately. See the indoor product installation instructions for the full range of airflow settings.

Airflow Considerations

INDOOR CFM RANGE							
2-Ton (024 & 025)		3-Ton		4-Ton		5-Ton	
Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
222	850	236	1200	350	1600	420	2000
* Minimum airflow at Comfort setting, Maximum at Max setting							

Many heat pump applications will require selections made based on heating loads; as a result, the CFM ranges of the units will be wider than those of conventional heat pump systems. The high end will be higher airflow and the low end will be lower airflow.

For all units consideration should be made with respect to duct system sizing. If the ductwork is undersized, constant airflow indoor products will raise blower speed to meet the commanded CFM, resulting in higher static pressures, excessive duct noise, and higher power consumption, along with the possible shortening of motor life. Pulse-width modulations (PWM)-driven indoor products (not constant airflow) are more sensitive to duct sizing. Consult ACCA Manual D for duct sizing procedures if there is a question.

Lower, low-end CFM could result in little or negligible airflow to conditioned spaces, especially on long duct runs or if the ductwork is oversized. This could be very troublesome on zoned systems not capable of delivering the required airflow to each zone when all zones require air. Consult ACCA Manual D for duct sizing if in question.

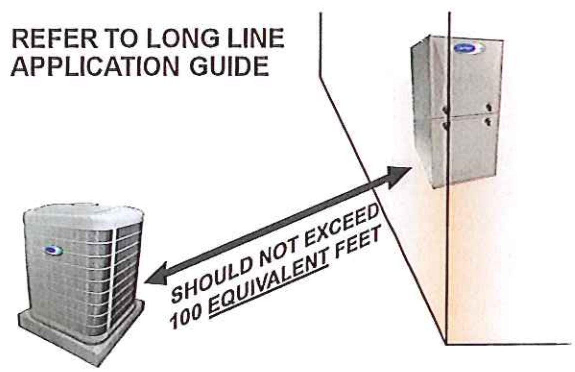
Shown in the table are minimum and maximum airflows for the variable-speed air conditioners and heat pumps. Ductwork should be sized for the maximum airflow in the tables. If the ductwork is undersized, consider using an alternate stage setting that will deliver lower maximum airflows. Consult the product installation guides for alternate stage settings.

Recommended air supply velocity for a residence should be between 500 and 750 feet per minute.

The low CFM is not applicable to a Hybrid Heat® system using a gas furnace when the gas furnace is in gas heat mode. Use ACCA Manual D for the design of the duct system.

Refer to the product data literature for comfort and efficiency airflows for these products.

Long Line Applications

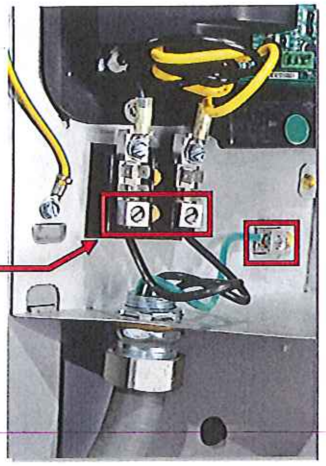


Both the air conditioner and heat pump models are approved for up to 100 feet of equivalent length separating the indoor unit and the outdoor unit without any accessories added. Refer to the unit's installation instructions and the long line guidelines for the proper application guidelines and any other limitations that may apply.

Unit Electrical Power

Field wiring connection:

- 197 to 253 volts
- Replaces contactor

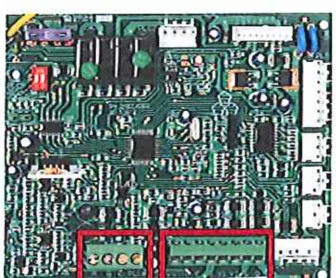


WIRING CONNECTION

Ensure that field wiring complies with local and national fire, safety, and electrical codes, with the voltage to the system no lower than 197 volts and no higher than 253 volts. Operation of the unit on improper line voltage will cause the system to generate fault codes and potentially lock out. If the voltage to the unit is not within these limits, the local power company must be contacted to the correct the voltage.

The installed circuit protection device must be the one specified on the unit rating plate.

Power wires from the unit's disconnect should be routed through the power wiring hole provided at the bottom of the unit's control box. Connect the ground wire to the ground connection in the control box and connect the power wiring to the terminal block as shown. This is also indicated on the unit wiring diagram on the unit and Installation Instructions supplied with the unit. The AOC board does not require a separate contactor in order to operate the compressor.



Control wiring connections:

- AB plug used for communicating applications
- Discrete 24VAC connections used for 2-stage applications **(must connect 24VAC to R)**

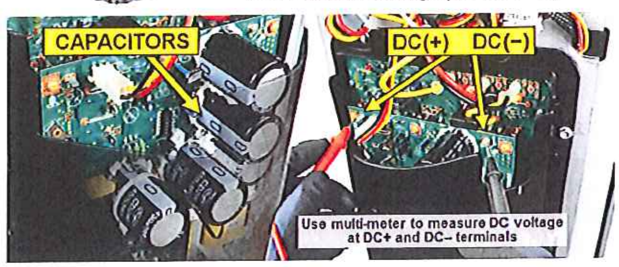
Connect the communication control wire connections A and B from the indoor unit to the ABCD plug on the outdoor unit AOC board or use discrete 24 VAC inputs for 2-stage applications. Note that 24VAC power must be connected to the R terminal for non-communicating (2-stage) applications in order for the unit to operate.

Familiarization

In the Familiarization section of this program we will take the unit apart and review the components of the variable-speed air conditioner and heat pump system. We will discuss how some of the components operate and how they function to protect and control operation of the entire system. Many of the components are common between the air conditioner and the heat pump. We will discuss the common components and then discuss the components specific to the heat pump.

Removing the Control Box Cover

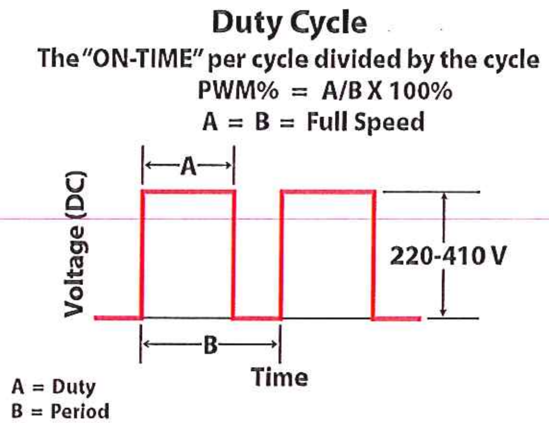
- Capacitors maintain a **lethal** high-voltage charge
- Remove power at least two minutes before service
- Lockout and tag electrical disconnect
- Take readings at DC+ and DC– terminals to ensure full discharge (DC VDC = 0)



In this view, the access panel covering the unit's control box has been removed. Precautions must be taken when servicing components within the control box of this unit. The variable-speed drive (VSD) contains several capacitors for converting electrical current. These capacitors maintain a lethal high voltage charge. They are covered with a protective shield that is designed to be permanent and must not be removed. If service is to be performed near the VSD, power must be removed from the unit at least two minutes before the service is to be performed to allow the capacitors to slowly discharge. Then, before any work is performed on or near the VSD, electrical meter readings must be taken at the DC + VOLTAGE and DC - VOLTAGE terminals on the VSD adjacent to the capacitors to ensure that they have totally discharged. The volts DC must be 0 (zero).

The technician performing the service must determine that it is safe to work on or near the VSD. The electrical disconnect that provides power to the unit must not only be turned off, but must also be locked and tagged off. This will also ensure that no damage will occur to the VSD, controls or the equipment and that no one will get hurt if they come into contact with the electrical equipment.

Variable-Speed Drive (VSD) Advantage

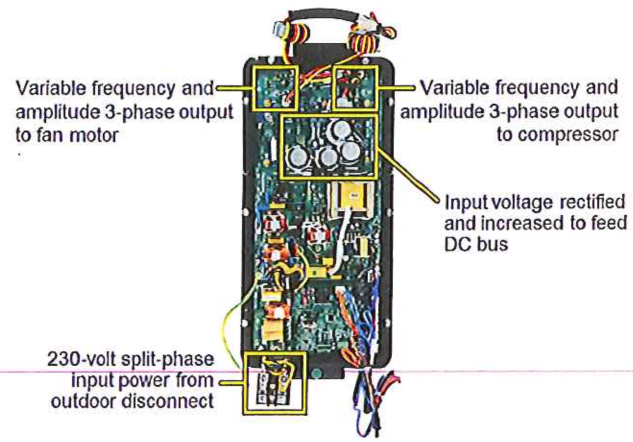


The primary purpose of the VSD is to convert the 60-Hz AC input voltage into the variable-frequency/variable-voltage output needed to power the variable-speed rotary compressor. Through a series of processes, the drive converts the incoming 230-volt split phase AC power to a 3-phase output. The drive first converts the AC input voltage into a DC bus voltage. IGBT's (Insulated Gate Bipolar Transistors) recreate a 3-phase sine wave current at the desired frequency and voltage. The frequency of the VSD output current determines motor speed, while its amplitude determines torque.

The PWM (Pulse Width Modulated) signal is created by turning a DC signal on and off once within a given period of time. The signal sent to the motor would look very similar to the "square wave" in the figure. The speed of the motor is determined by the width of the "A" signal sent to the motor electronics. The point from where the first square waves starts to the point where the second square wave starts, "B", is a constant. The ratio of the length of "A" to "B" is the speed that the motor will run. The wider the "A" signal, the faster the motor will run. If A = B the motor will run at 100% torque, which would be the maximum speed that the motor is programmed. The torque of the motor is determined by the height (voltage) of the wave. At full torque the DC voltage would measure approximately 410 volts.

If we had a continuous, A = B, DC signal at the motor, then the motor would be operating at full speed, in our case up to 5,400 RPM in heating on some units. If the DC signal is on for 4 milliseconds of the 5-millisecond period the motor will only see the 80% signal and the motor will operate at 80% speed or 4, 320 RPM. By changing the duration of time that the signal is on to the full time period the motor speed can be varied from zero up to its full speed.

Variable-Speed Drive Operation

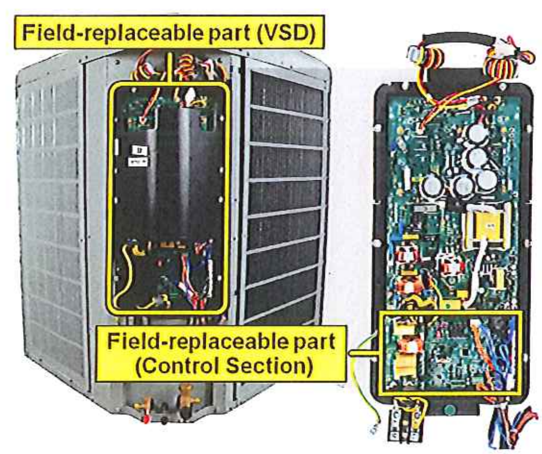


The variable-speed drive contains three functionally defined areas. At the bottom of the VSD, 208/230-volt AC power is brought into the drive. The middle section of the VSD takes 208/230 VAC power and converts it to a DC voltage of approximately 410-volts to supply the DC bus.

The upper portion of the VSD is the inverter section, which converts the DC voltage into a 3-phase square wave voltage at the desired frequency and amplitude. At the top of VSD, 3-phase voltage is supplied independently as outputs to the compressor and fan motor.

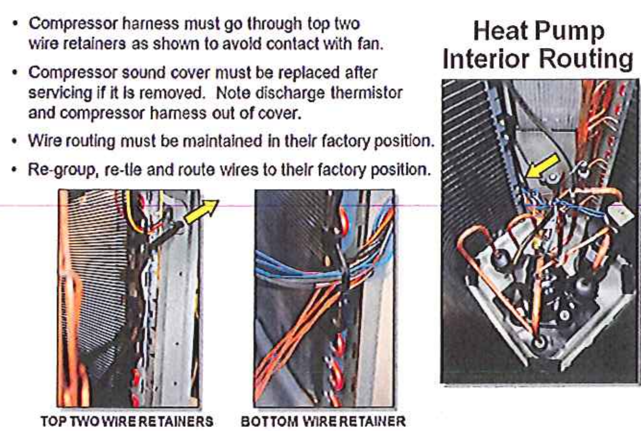
The lowest portion of the VSD is the AOC board and is the control section, which receives inputs from the many sensors in the unit and provides the communication to the VSD for its operation.

Servicing the VSD

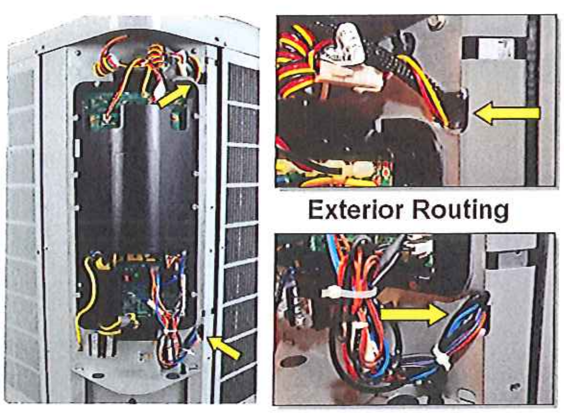


The majority of the VSD is not serviceable. If service troubleshooting determines that the AOC control section of the VSD has failed, a replacement part can be obtained through your distributor part department. If troubleshooting determines that any other component of the VSD has failed, the entire VSD must be replaced. When replacing the VSD, remember to allow two minutes after power shutdown for the capacitors to discharge to zero volts. Check the capacitors with an electrical meter before removing wires from the VSD.

Wire Routing Around the VSD



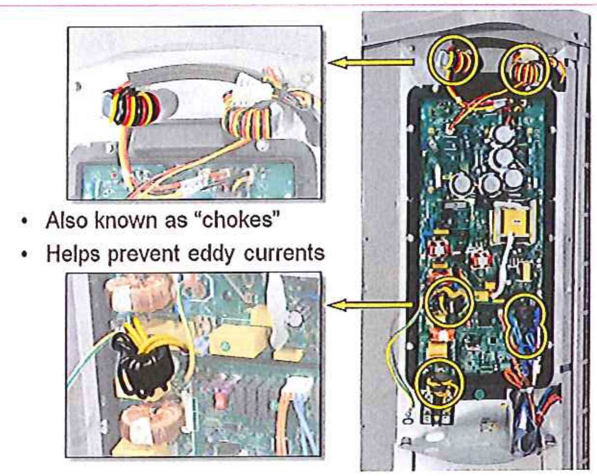
Wire routing, wire tie-downs, wire restraints and wire separation are very important to the operation and quality of this product. Wire routing from the factory must be maintained and wires must not be moved from their factory installed position. The same is true with the use of wire tie-downs and restraints. If during service, tie-downs are cut and removed or restraints are removed, they must be replaced in exactly the same spot where the factory placed them.



Wire separation is also extremely important; wires cannot be bundled together when replacing wire ties because power source wires could easily interrupt unit communication through the communication bus wires. Wire routing must also be maintained to stop water from entering wire encasements and ultimately the control box, as well as to keep wires away from moving parts.

It is recommended that you use this training program referring to sections that display wire routing so that it can be used on the job site as visual examples of the original factory wiring.

Ferrite Cores



The ferrite cores are the gray cylinders wrapped with wire. They are also known as chokes. A ferrite core is a structure on which the windings of electric transformers and other wound components are formed. Their powerful magnetic fields and low electrical conductivity help prevent eddy currents.

Because of the job that a VSD performs in turning a single-phase alternating current into a three-phase direct current, electro-magnetic interference (EMI) and radio frequency interference (RFI) are produced. Ferrite cores are EMI and RFI chokes; that is, they are able to absorb electrical interference while allowing data signals to pass unimpeded.

When performing service or replacing the VSD, make sure that the ferrite cores remain in their factory positions and also ensure that the wire turns through and around the ferrite cores remain the same as installed at the factory.

Outdoor Fan Motor

Compact ECM Motor
(also referred to as Brushless DC)
- Variable speed motor
- Operates from 500 to 1050 RPM
- Driven by inverter
- No control module attached

The outdoor fan, located at the top of the unit, draws air from outside the unit through the outdoor coil and also across the fins on the heat sink of the VSD heat exchanger to cool the VSD. The air is discharged upwards through the protective grille covering the fan motor. This grille provides protection to anyone placing their hands or fingers on top of the unit. The motor is totally enclosed for increased reliability and to eliminate the need for a rain shield. The ball bearings are permanently lubricated and require no maintenance.

The compact ECM outdoor fan motor is a variable-speed brushless DC (BLDC) motor that operates at speeds from 500 to 1,050 RPM. The motor is a 3-phase DC permanent magnet-type motor. Just like the compressor, this motor speed is determined by the inverter output frequency and amplitude.

The motor speed is controlled through the inverter board in the outdoor unit and no additional electronic module is attached to the fan motor. The motor speed is slowed as the building load decreases, maintaining the proper condensing temperature for both cooling and dehumidification. As the building load increases, the motor will increase speed until it is at maximum speed at the maximum building load.

At unit start-up, there is a slight delay and thrust motion of the fan motor/blade in the reverse direction, prior to ramping-up the fan assembly.

Main Control Box

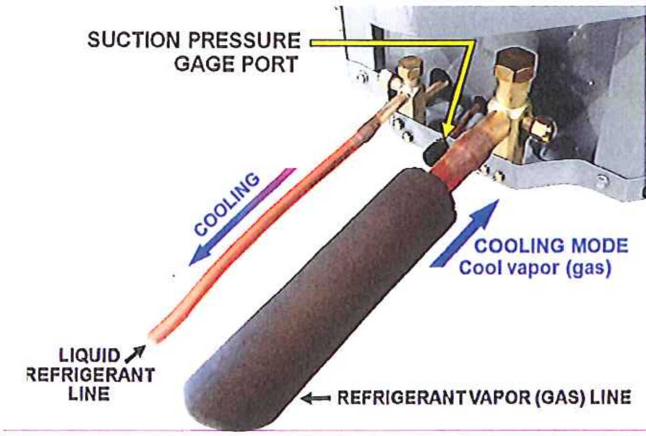
Located below the VSD is the unit's measurement and communication section. Control and communication for the outdoor unit is completely integrated into the AOC board. No external contactor or transformer is needed with this unit design. An outdoor air thermistor which extends through the bottom of the control box is exposed to the outdoor air temperature.

The power to the compressor is provided through the VSD. Because no contactor is used in this product, the entire circuit board has the potential that voltage will be applied whenever the outdoor disconnect is energized.

If the control board determines that sump heat is required, the AOC board will provide power to internally heat the compressor and ensure that no liquid refrigerant settles in the compressor while the unit is not operating. Once the indoor thermostat or UI determines that there is a demand for heating or cooling, the VSHP board will begin to ramp-up the compressor to the required speed.

The outdoor unit's main power enters the unit through the bottom of the control box and connects to the primary terminals of the terminal block. The communication control wires from the indoor unit enter the bottom of the control box, and then attach to the communicating control connector, which is then inserted into the mating ABCD plug. If a non-communicating control is used thermostat wires are connected to the 24VAC discrete connections on the AOC board.

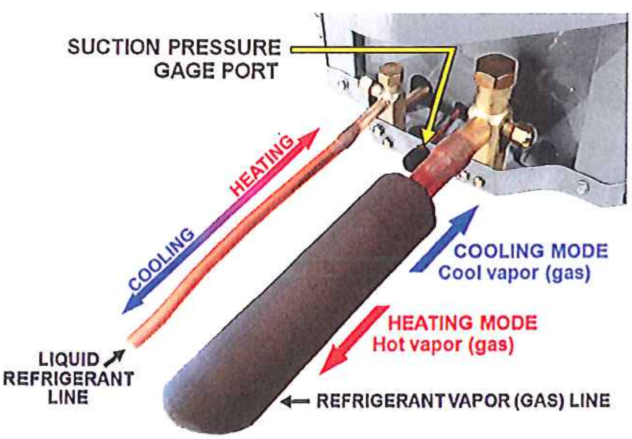
AC Refrigerant Service Valves



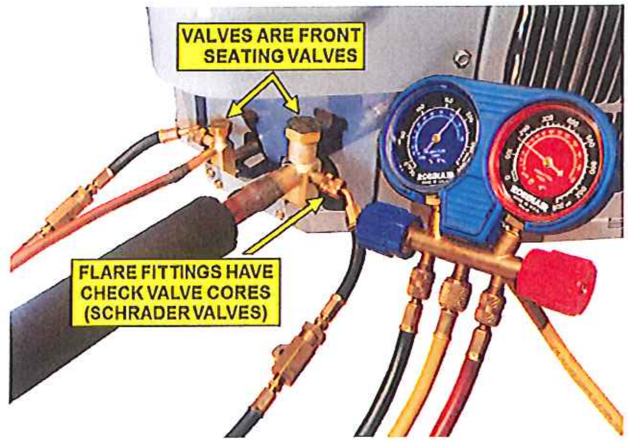
The two brass service valves serve as the connection point for the refrigerant line set from the indoor unit coil to the outdoor unit. In the cooling cycle, cool refrigerant vapor at low pressure flows to the outdoor unit from the indoor unit through the larger valve. At the same time, refrigerant liquid at higher pressure flows from the outdoor unit to the indoor unit through the smaller valve.

Gauge ports are located on the sides of each valve for connection of refrigerant gauges. The valves are front-seating to close. Check-valve cores, also known as Schrader valves, are provided within the flare connections on the service valves.

Heat Pump Refrigerant Service Valves

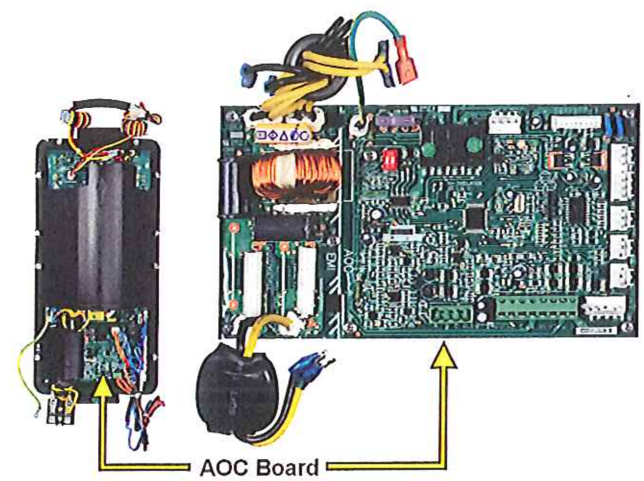


In cooling the service valves and refrigerant flow are the same as with the air conditioner. During the heating cycle, hot refrigerant vapor at high pressure flows from the outdoor unit to the indoor unit through the same larger valve as in the cooling mode, while refrigerant liquid at slightly lower pressure flows from the indoor unit back to the outdoor unit through the smaller valve.



Gauge ports are located on the sides of each valve for connection of refrigerant gauges. However, since low-pressure vapor flows through the large valve during the cooling cycle, and high-pressure vapor flows through the same valve during the heating cycle, the technician servicing the product would have to change low side and high side gauge connections from heating to cooling and back to heating each time the unit was checked. To simplify taking pressure readings, a third gauge port has been added between the two valves, to take suction pressure readings in both the heating and cooling modes.

AOC Application Operation Control Board



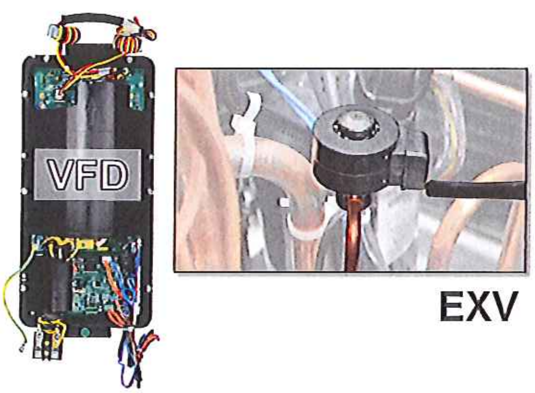
The AOC board is located directly below the variable-speed drive motor operating control (MOC). The AOC controller is a two-wire serial-communicating device that receives capacity demands from the UI and communicates the corresponding speed request to the VSD that controls the compressor speed. With the use of the suction pressure transducer, the outdoor suction line thermistor, the outdoor air temperature thermistor, the outdoor coil thermistor and feedback from the VSD, the controller actively tries to prevent fault trip events. In addition, the high-pressure switch and discharge temperature thermistor (ODT) prevent unsafe operation due to abnormally high pressure or temperature.

Integration of the indoor blower speed with the compressor speed in the cooling mode results in increased dehumidification of the occupied space.

When the system is installed with a communicating indoor furnace or fan coil, the UI control provides a service aid for the installer and service technician. A charge assist feature is built into the control that runs the system at fixed settings and provides the charge weigh-in amount.

Fault detection and diagnostics are supported by fault codes passed from the outdoor unit and VSD to the UI. The fault codes contain a description, as well as a record of the last 10 events with the date, time and frequency. These fault codes are listed in the Installation Instructions.

AOC Heat Pump Application



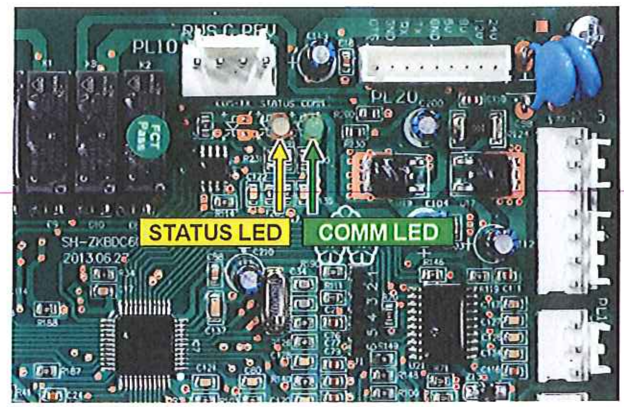
Cooling operation in the heat pump unit is the same as the air conditioner. In heating, these components together with the electronic expansion valve (EXV), allow the AOC board to provide control of the heating superheat.

With the extended compressor speed range and motor speeds up to 5,400 RPM during the heating cycle at lower outdoor ambient temperatures, more heating comfort can be provided to the occupied space because the higher compressor speeds will maintain higher suction and discharge pressures. This will result in higher heating temperatures at low outdoor air temperature conditions. The AOC board is also capable of intelligent defrost.

When the heat pump system is used with a communicating control and it is in the refrigerant charge evacuation mode, the EXV is held open to allow for complete removal of the system refrigerant charge.

Through the user interface (UI), the EXV can be opened or closed on command to the heat pump controller, allowing the service technician to check the operation of the EXV audibly in the OFF mode.

AOC Board LEDs



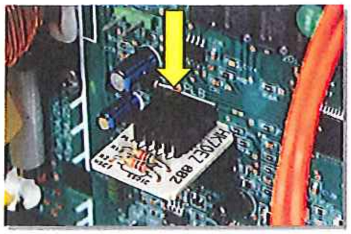
The AOC board contains two light-emitting diodes (LEDs): a green LED identified as COMM that signals communications; and an amber LED identified as STATUS that signals status.

The green LED will remain off until communication is established. Once a valid communication is received, the green LED will turn on. A time of 2 minutes is given for the communication to be established. If no communication is established, the green LED will be off. A steady green light indicates that successful communication with the other system products has been established. If communication between the control and the UI is lost, the control will flash the appropriate fault code.

The amber LED is used to display the operation mode and the fault codes. Only one fault code will be displayed on the outdoor unit control board: the most recent with the highest priority. However, the UI will retain the last ten system faults in its memory. These can be viewed through the UI.

If the AOC board fails, the board will display the appropriate fault code and the UI will display the fault as well. If this occurs, the AOC board should be replaced.

AOC Board Model Plug



AIR CONDITIONER MODEL PLUGS

Model Number	Model Plug Number	Pin Resistance (Ohms) Pins 1 – 4	Pins 2 – 3
24VNA925	HK70EZ011	5.1K	150K
24VNA936	HK70EZ012	5.1K	180K
24VNA948	HK70EZ013	5.1K	220K
24VNA960	HK70EZ014	5.1K	270K

Every control board contains a model plug. The correct model plug must be installed in order for the system to operate properly. The model plug is used to identify the type and size of the unit to the control. If a model plug is lost or missing at initial installation, the unit will operate according to the information input at the factory and the appropriate fault code will flash temporarily. However, the model plug takes priority over the information input at the factory. If the model plug is removed after initial power-up, the unit will operate according to the last valid model plug installed, and flash the appropriate fault code.

If the model plug part number is illegible or missing or if the AOC board does not recognize the unit with the model plug in place, the model plug can be identified and the resistances verified by checking the resistance values across pins 1 and 4, then 2 and 3, as indicated in the chart.

On new units, the model and serial number are input into the board's memory, not the model plug, at the factory. A service replacement board contains no model and serial number information and does not contain a model plug. If the factory control board is replaced, the model plug must be removed from the original board and transferred to the replacement board in order for the unit to operate.

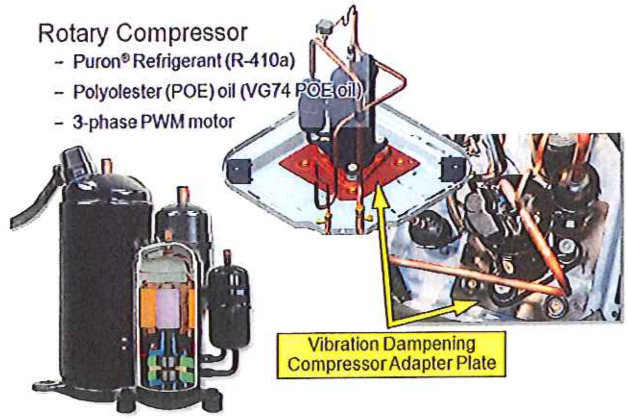
HEAT PUMP MODEL PLUGS

Model Number	Model Plug Number	Pin Resistance (Ohms) Pins 1 – 4	Pins 2 – 3
25VNA825	HK70EZ001	5.1K	11K
25VNA836	HK70EZ002	5.1K	18K
25VNA848	HK70EZ003	5.1K	24K
25VNA860	HK70EZ004	5.1K	33K

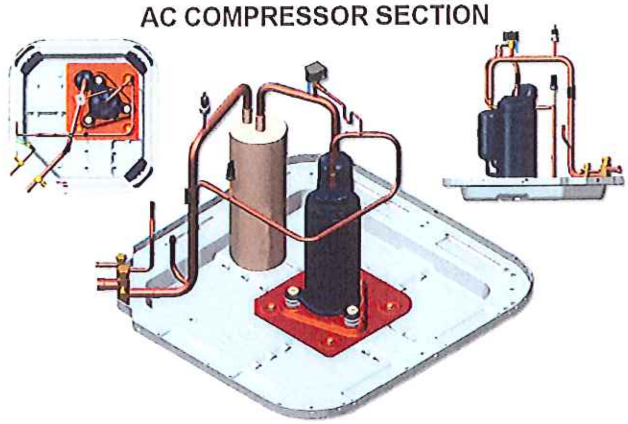
NOTE THE DIFFERENCE IN RESISTANCE FROM THE AIR CONDITIONER

Notice that the air conditioner and the heat pump model plugs are similar however the resistance of the plugs for a given unit size are different.

Compressor Section



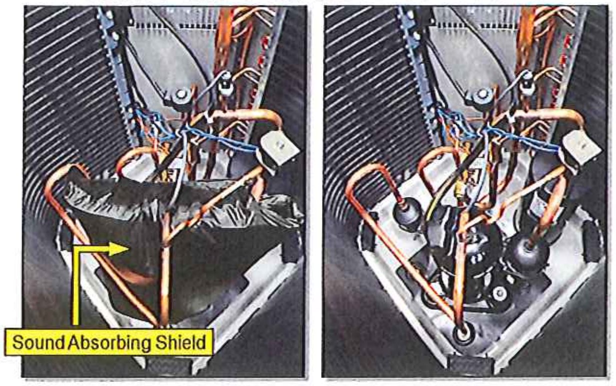
AC COMPRESSOR SECTION



The compressor is located in the center of the unit's base pan. The compressor base plate is a three-legged mount that is installed with a grommet on a sound-absorbing adapter plate, which in turn is bolted to the base pan.

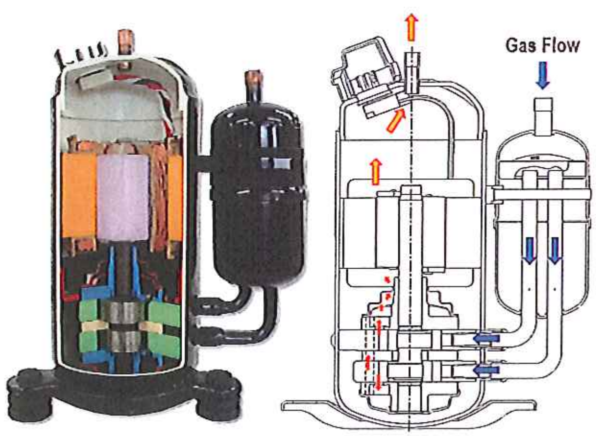
With all size compressors an integral accumulator located on the suction line of the compressor holds liquid refrigerant while allowing suction gas to flow through. In most units an auxiliary accumulator that also helps hold the liquid refrigerant while allowing the refrigerant vapor to flow through is located in the suction line before the integral accumulator. These accumulators have a debris filtering screen. The 24VN9 2 Ton and 3 Ton air conditioners do not require the auxiliary accumulator. This extra accumulator is helpful for the rotary compressor because suction gas is fed directly into the compression chamber making them more sensitive to liquid refrigerant and particulates. All units use rotary compressors with Puron® R-410A refrigerant with polyolester (POE) oil for lubrication. These rotary compressors use VG74 POE oil, which must be the replacement oil, if that became necessary. Replacement with other POE oils can result in premature failure. Unlike a single-stage rotary compressor, this compressor uses a 3-phase PWM motor.

HEAT PUMP COMPRESSOR SECTION



The compressor is encased in a sound-absorbing shield to muffle some of the high-pitched sound that is emitted at the higher operating speeds. This enclosure is sized to also enclose the outdoor discharge thermistor (ODT), thus reducing the influence of outdoor ambient conditions on true discharge temperature sensing. If the sound enclosure is removed for any reason, it must be replaced in such a manner that the compressor and ODT are fully enclosed, with the Velcro® properly reattached.

Compressor Internal

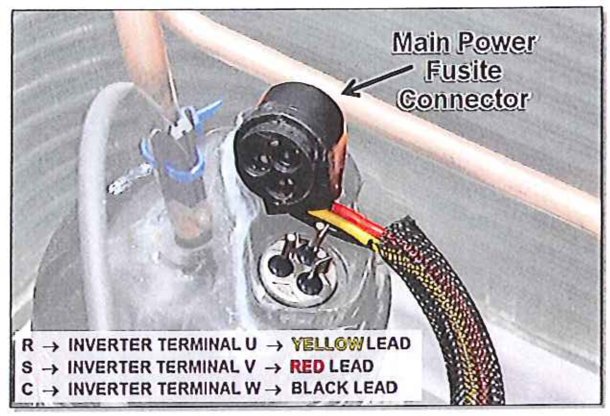


In this internal view of the two-cylinder rotary compressor, blue arrows represent the suction gas entering through the integral accumulator, where it is split into two streams that are channeled through two tubes to the two compressor cylinders. The orange arrows represent the compressed discharge gas that fills the rest of the compressor shell, making this a high-side compressor. The discharge gas exits the shell through a stub-out at the top. **Note that the high-side compressor is hot while operating, not just at the dome, but on the entire shell.**

The dual-cylinder rotary compressor provides some balance and stability, resulting in reduced vibration and noise, in comparison to a single-cylinder rotary compressor.

Rotary compressors are susceptible to damage from low suction pressure. Precaution has been taken in the operation of this compressor to never allow suction pressure to be lower than 33 psig for more than 5 minutes and never to be below 15 psig. Therefore, when this compressor starts up, it ramps-up more slowly than other types of compressors. In addition, suction pressure verification is done at each stage of operation before attempting the next stage. Therefore, at lower ambient heating conditions, staging-up will be slower due to the time taken in building a safe suction pressure during each stage.

Compressor Fusite Connections



These compressors have terminals that are marked as follows:

R matches up with the inverter terminal U connected with a Yellow lead

S matches up with the inverter terminal V connected with a Red lead

C matches up with the inverter terminal W connected with Black lead.

There is no need for the ground lead from the compressor, since the suction tube is used to complete the ground path from the compressor.

The heater for the compressor is internal to the compressor. It uses the motor windings, which are energized through the VSD during the off cycle and on demand by the system to prevent the compressor from becoming the coldest part of the system. This is done by staging the power to the winding in three different stages. When in the off cycle, and the outdoor air temperature is greater than 75°F, 50W power will be provided to the winding only if the outdoor air temperature is rising for 4 straight hours. On the other hand, if the outdoor air temperature is between 45°F and 75°F, 50W power will be provided after a two-hour off cycle has elapsed. If the outdoor air temperature is between 20°F and 45°, 75W power will be provided to the winding after a 1.5-hour off cycle has elapsed. Also, if the outdoor air temperature is between 0°F and 20°F, 100W power will be provided to the winding after a one-hour off cycle has elapsed. However, at the first time power-up, the stator heat will be powered for 6 hours and the power level will be based on the ambient as explained before. When Compressor Sump Heating Active is in effect, the fault code 68 will be displayed by the STATUS LED during the sump heating time.

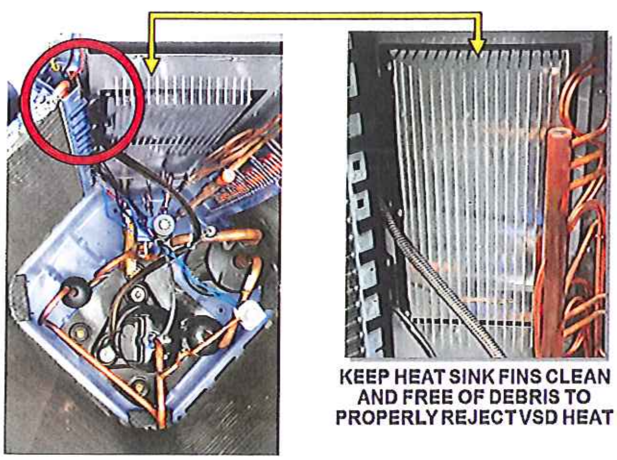
Rather than being protected by an internal pressure relief, the protection is provided by the system high-pressure switch and compressor torque management through the VSD and the discharge temperature thermistor (ODT).

The operational speed capability of the motor in this compressor is considerably higher than that of other single- or two-stage compressors. Scroll compressors have two-pole AC motors, which have a synchronous speed of 3,600 RPM but operate at around 3,450 RPM due to slippage. The four-pole compressors incorporated into these variable-speed heat pumps operate at a maximum speed listed in table below.

Compressor Speed in RPM

Size	Cooling	Heating	Minimum
25	4,700	5,400	1,500
36	4,800	5,400	1,200
48	4,320	5,400	1,500
60	4,140	5,400	1,200

Compressor Section & VSD Heat Sink

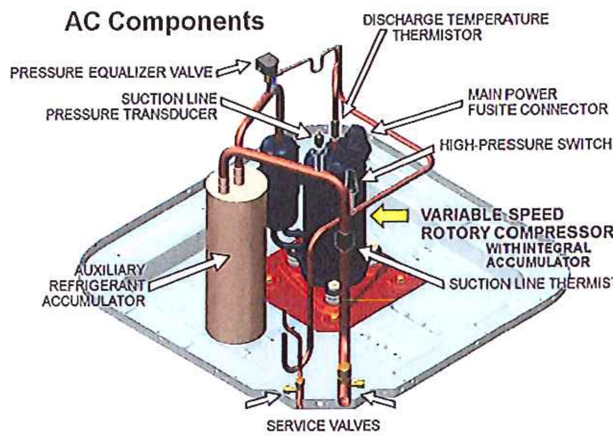


KEEP HEAT SINK FINS CLEAN AND FREE OF DEBRIS TO PROPERLY REJECT VSD HEAT

Take a close look at the top of this picture between the header end of the outdoor coil on the right and the hairpin end of the outdoor coil on the left. The visual is showing the back side of the VSD, which is the heat sink. Its fins are used to reject heat from the VSD. **In order to properly reject the heat developed by the VSD, these heat sink fins must be kept clean and free of debris.**

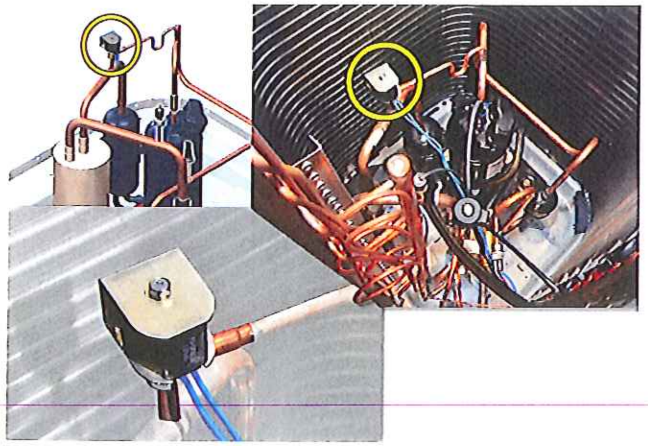
Also, take a close look at the distributor feeder tubes located close to the inverter fins. An inadvertent situation may occur during service or shipping where these feeder tubes may touch the inverter heat sink fins. This will wear a hole on the wall of the feeder tube, causing loss of refrigerant charge. **Care must be taken to avoid this by carefully moving the feeder tube bundle away from other metal parts.**

Air Conditioning Compressor Section Components



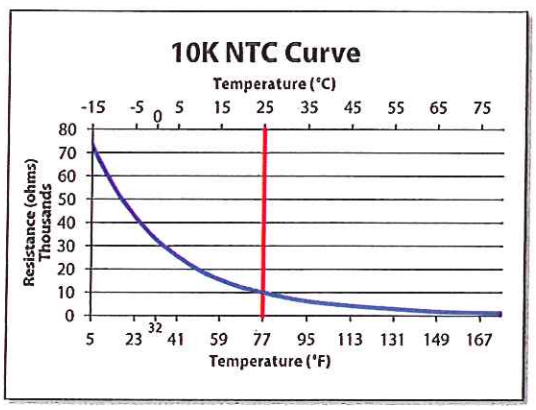
Now look at the components arranged around the compressor in this section. Attached to the compressor is the integral accumulator on the suction line which has two lines that enter the compressor. Directly in front of the compressor on the discharge line is the high-pressure switch. To the left of the compressor is the auxiliary accumulator. In front of the compressor on the suction line going to the auxiliary accumulator is the low-pressure transducer (Suction Line Pressure Transducer). A suction line thermistor is also attached to the suction line. Directly above the compressor discharge stub a Discharge Thermistor (ODT) tube is located. The function of this temperature measurement device is to prevent a failure of the compressor due to over-temperature (> 240°F). Therefore, the thermistor must be tightly secured around the discharge tube for a reliable temperature measurement.

Pressure Equalizer Valve (PEV)



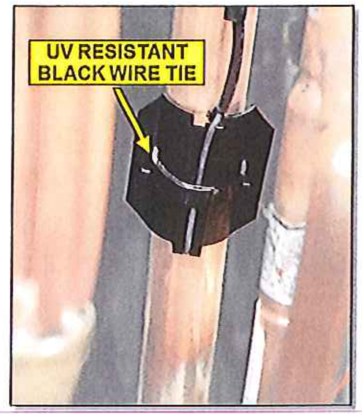
A PEV is located immediately next to the suction and discharge of the compressor. The function of this valve is to prevent the compressor from starting with a high refrigerant pressure differential, thus helping with the reliability of the compressor. Therefore, at every compressor startup, or re-start after the 3.5-minute time guard delay, the equalizer valve opens for 150 seconds plus another 15 seconds of protection before allowing the compressor to start ramping-up. A hissing sound may be herd during the equalization process; this is normal.

Thermistors



Thermistors are electrical devices in which the resistance changes in a proportional, predictable response to temperature changes. The thermistors used on this product are negative temperature coefficient (NTC) temperature sensors, meaning that the resistance through the thermistor rises as the temperature decreases. The air conditioning unit uses two thermistors. One 10K ohm thermistor is used to sense outdoor suction line temperature (OST), and one 50K ohm thermistor is used to sense outdoor discharge temperature (ODT). The heat pump unit uses two additional 10K ohm thermistors, one to sense outdoor air temperature (OAT), one to sense the outdoor coil temperature (OCT).

Suction Line Thermistor (OST)

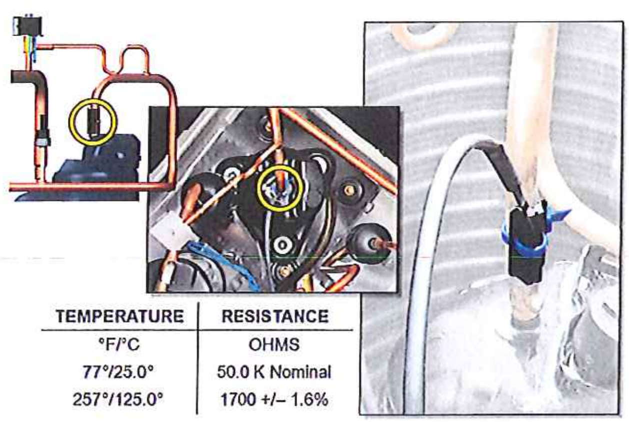


In the air conditioning unit the Suction Line Thermistor (OST) is located on the suction line before the accumulators. The OST is used in the air conditioning unit for system charge determination. In the heat pump, the OST is located on the suction line between the accumulator and the reversing valve, a short distance from the suction line transducer. In the heat pump the OST is used to assist in EXV control and system refrigeration charge determination.

When performing service to the OST, check and note that it should be mounted exactly in the position shown in this visual. It must be secured tightly to the suction line aligned, longitudinally along the tube axis in the vertical position. The curved surface of the thermistor must hug the curved surface of the suction line and secured tightly using the UV resistant black wire tie fished through the original slot of the insulating polymer body in order to minimize the influence of ambient temperatures. This is very important for the operation of this unit.

If the OST should fail, the control will flash fault code 54.

Discharge Temperature Thermistor (ODT)



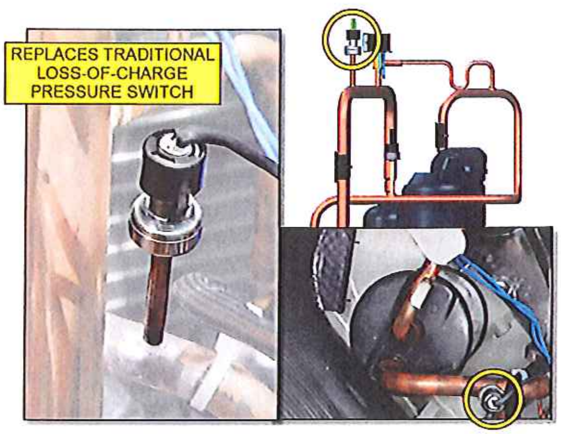
TEMPERATURE	RESISTANCE
°F/°C	OHMS
77°/25.0°	50.0 K Nominal
257°/125.0°	1700 +/- 1.6%

Both the air conditioner and the heat pump are equipped with a 50K ohm thermistor that is used to measure the discharge tube temperature. It is known as the ODT. The resistance values based on the room ambient and temperature around the trip point are shown below:

Temperature	Resistance
°F /°C	OHMS
77°/25.0°	50.0 K Nominal
257°/125.0°	1700 +/- 1.6 %

The discharge tube temperature on these units is not allowed to exceed (within the tolerance) the 240°F limit in order to prevent overheating damage to the rotary compressor. If the system exceeds this limit, the compressor will trip. The compressor operation will be modified and the system will run at a lower stage if this trip repeats. If the ODT should fail, the control will flash fault code 52.

Suction Line Pressure Transducer

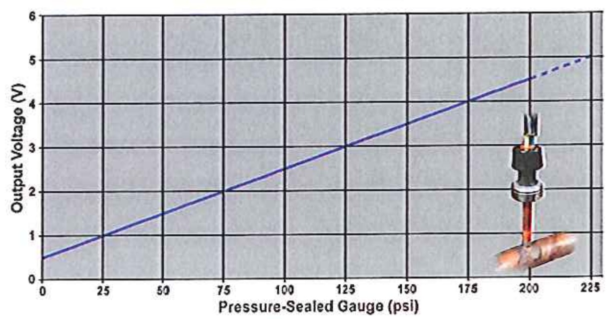


The suction line low pressure transducer interprets the pressure data used by the AOC board for low pressure cutout; loss of refrigerant charge protection; oil circulation and lubrication management; EXV control (on heat pumps); and compressor overall envelope management.

On the air conditioner the suction line pressure transducer is located on the suction line before the accumulators. The suction pressure transducer is brazed directly to the suction line. Should it fail, the refrigerant in the outdoor unit will require removal and recovery before the failed switch can be removed and replaced.

Heat pumps have a suction line pressure transducer mounted on the suction line between the accumulator and the reversing valve. This transducer replaces the traditional loss-of charge pressure switch ordinarily used on the liquid line of a heat pump.

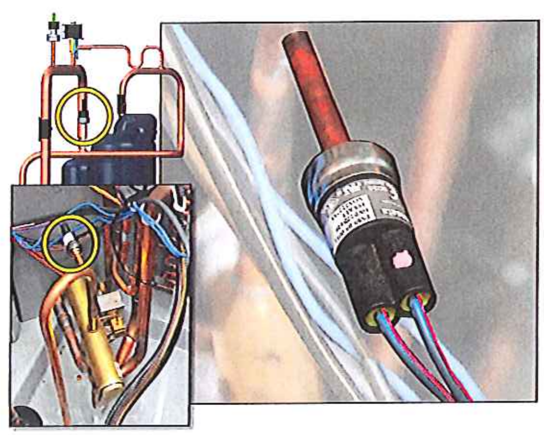
Pressure Transducer Interpretation



The low-pressure transducer provides a 0.4 to 5 volt DC signal to the AOC board. The AOC control board then translates the 0.4 to 5-volt signal to pressure proportionally from 0 to 200 psig. This translated pressure is then used by the AOC board to shut down the unit at the appropriate low-pressure setting. It also provides protection and management of loss of charge; management of compressor overall envelope operation; management of oil circulation and lubrication; and control of the EXV (in heat pumps). If the suction pressure transducer should fail, the control will flash fault code 57.

The control will flash fault code 32 if the AOC senses a low pressure trip. If the low pressure trips on three consecutive cycles, the operation of the unit will be locked out for 4 hours and the control will flash fault code 83.

High-Pressure Switch (HPS)



The HPS is located in the discharge line from the compressor and shuts down the compressor when high side system pressures are abnormally high. It is brazed directly to the discharge line. Should it fail, the refrigerant in the outdoor unit will require removal and recovery before the failed switch can be removed and replaced.

If the AOC board senses that the HPS has opened, it will de-energize the compressor and the control will flash fault code 31.

After 15 minutes, if the HPS has closed, and if there is a call for heating or cooling, the compressor will start.

If the open HPS closes any time after the 15-minute delay, the unit will resume operation with a call for cooling or heating at a temporary reduced capacity stage. If the HPS trips on three consecutive cycles, the operation of the unit will be locked out for 4 hours, and the control will flash fault code 84.

Heat Pump

AOC Ideal Defrost

HEAT PUMP IDEAL DEFROST

AUTO Defrost Demand

- Outdoor coil temperature monitored
- Demand = or < 32°F for 4 minutes
- Demand = OAT < 50°F
- Terminated at 65°F or after 10 minutes
- Terminated if OAT > 35°F and OCT > 50°F
- Terminated if OAT < 35°F and OCT > 40°F
- OFM 20-second OFF after defrost when in heat mode
- Interval starts over if coil temperature > 65°F

AUTO Defrost Interval

- Initial power up = 30 minutes first interval
- Defrost time < 3 minutes = 120 minutes
- Defrost time 3 to 5 minutes = 90 minutes
- Defrost time 5 to 7 minutes = 60 minutes
- Defrost time > 7 minutes = 30 minutes

In the past, defrost intervals have been selectable from 30 minutes to 120 minutes in 30-minute intervals. The communicating controls have added the new Ideal Defrost, which is the AUTO selection for an intelligent defrost interval made by the controls. AUTO is the default setting when used in a heat pump with the communicating controls.

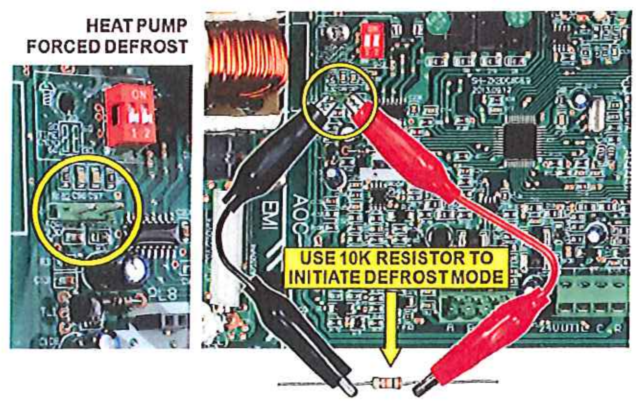
The communicating controls count the compressor run time minutes. As the accumulated run time approaches the defrost interval time, the communicating controls monitor the outdoor coil temperature sensor for a defrost demand. If the outdoor coil temperature sensor is 32°F or lower for a period of 4 minutes, and the outdoor air temperature is below 50°F, a defrost demand has been established. If a defrost demand exists, the defrost cycle will initiate at the end of the selected time interval. If the coil temperature doesn't reach 32°F within the interval, the interval timer will be reset and start over.

When the communicating control heat pump is first commissioned and power is provided to the unit and the communicating controls, the first defrost interval will occur after a 30-minute time period until a defrost time interval is established. The defrost interval will be established based on the defrost time, as shown in the chart. For example, a 120-minute interval will be established if the defrost time took less than 3 minutes. However, the defrost interval will default to an interval not to exceed 60 minutes when the temperature is below 37°F, using auto or manual setting. If the manual setting is 30 or 60 minutes and the outdoor air temperature is below 37°F, the defrost interval will be 30 or 60 minutes as designated.

The defrost cycle is terminated when the coil temperature reaches 65°F, or after 10 minutes has elapsed. The defrost cycle is also terminated if the outdoor air temperature is greater than 35°F and the outdoor coil temperature is greater than 50°F, or if the outdoor air temperature is less than 35°F and the outdoor coil temperature is greater than 40°F.

The outdoor fan motor starts before the reversing valve shifts after termination of defrost.

AOC Board Forced Defrost



Either from using the Forced Defrost pins located on the AOC or thru UI heating checkout mode a forced defrost can be initiated. Shorting the terminals together with a 10k ohm resistor for a minimum of 7 seconds and then releasing will place the control into the defrost mode (Forced Defrost). The control action will be dependent upon the status of the coil and outdoor temperatures. If the coil temperature is at or below 32°F and the outdoor temperature is below 50°F, then the defrost mode will continue until normally terminated. If either the outdoor coil or outdoor air temperature does not meet the above requirements, then the defrost mode will be terminated after 30 seconds of active mode.

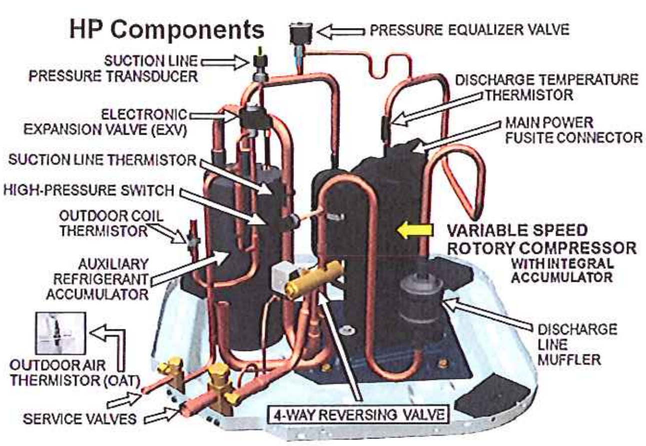
The above function will only occur if the short on the terminals is applied and then removed. A permanent short across the terminals will be ignored. If the Forced Defrost is initiated by a communicated command, the control will determine whether to allow a normal defrost or terminate after 30 seconds as described above. The control will signal the User Interface when termination has occurred.

HEAT PUMP FORCED DEFROST

SIZE	OAT <= 50F	OAT <= 50F & OAT > 25F	OAT <= 25F & OAT > 10F	OAT < 10F
25	3300 (Stage 5 Cooling)	3300 (Stage 5 Cooling)	3300 (Stage 5 Cooling)	3300 (Stage 5 Cooling)
36	3400 (Stage 3 Cooling)	4800 (Stage 5 Cooling)	4800 (Stage 5 Cooling)	4800 (Stage 5 Cooling)
48	3300 (Stage 3 Cooling)	4320 (Stage 5 Cooling)	4320 (Stage 5 Cooling)	4320 (Stage 5 Cooling)
60	3200 (Stage 3 Cooling)	4140 (Stage 5 Cooling)	4140 (Stage 5 Cooling)	4140 (Stage 5 Cooling)

The defrost RPM is the cooling maximum RPM as shown in the table. However, when the outdoor air temperature is greater than 50°F, the defrost RPM will default to a stage 3 cooling speed instead of the maximum cooling speed.

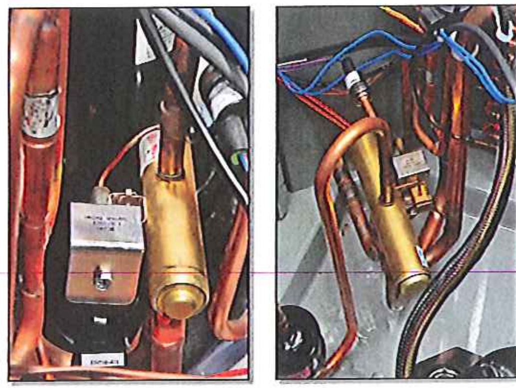
Heat Pump Compressor Section Components



Now look at the heat pump components arranged around the compressor in this section. Directly in front of the compressor is the four-way reversing valve and just above the reversing valve is a high-pressure switch in the discharge line. To the right of the compressor is the refrigerant accumulator, with a suction line pressure transducer mounted in the suction line entering the integral accumulator. Clockwise around the compressor is a discharge line muffler brazed to the discharge line. A suction line thermistor is also attached to the suction line, while an outdoor coil thermistor is attached to the liquid line where liquid refrigerant enters the distributor at the outdoor coil. An EXV is located in the liquid line just ahead of the outdoor coil thermistor.

Directly above the compressor discharge stub tube located a Discharge Thermistor (ODT). The function of this temperature measurement device is to prevent a failure of the compressor due to over- temperature (> 240°F). Therefore, the thermistor must be tightly secured around the discharge tube for a reliable temperature measurement.

Reversing Valve

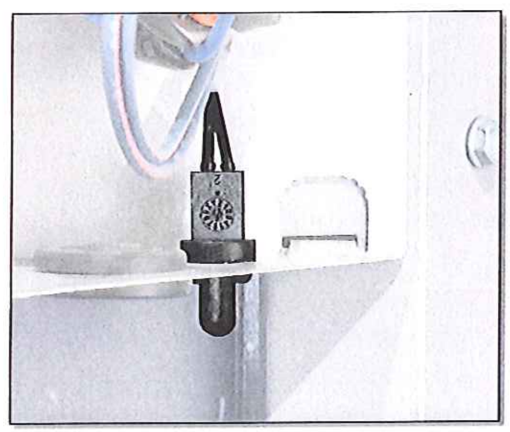


HEAT PUMP ONLY

The four-way reversing valve is provided with a removable and replaceable solenoid coil. To replace the coil, simply remove the screw holding the coil assembly to the valve body and remove the coil assembly; there is no need to remove the entire valve should the solenoid coil fail.

Unlike other heat pumps that use AC voltage, this solenoid coil is operated with DC voltage.

Outdoor Air Thermistor (OAT)

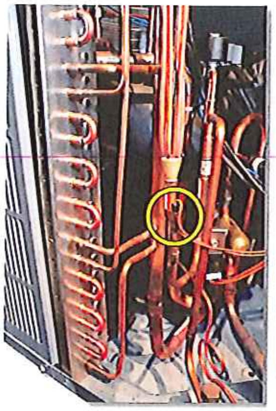


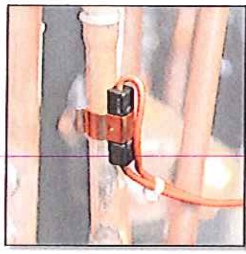
Operation of the heat pump requires two additional thermistors. The Outdoor Air Thermistor (OAT) is used on heat pump units in determining defrost cycles. The OAT takes its reading of the outdoor air temperature and feeds that information back to the AOC board and the UI, allowing the communicating control to make decisions and commands dependent on the outdoor air temperature.

When performing service on the OAT, check and note that it should be mounted exactly in the position shown in this visual. The thermistor must be locked in place with the spherical nib end facing towards the front of the control box. This is very important for the operation of this unit.

If the outdoor air thermistor should fail, defrost will be initiated based on the coil temperature and time. The control will flash fault code 53.

Outdoor Coil Thermistor (OCT)





OUT OF RANGE

COOLING MODE: OAT = or > OCT + 10
OAT = or < OCT - 20

HEATING MODE: OAT = or > OCT + 35
OAT = or < OCT - 10

The Outdoor Coil Thermistor (OCT) provides the coil liquid line temperature to the AOC board and the UI. It is the main device that puts the heat pump into defrost and takes it out of defrost. For some functions it works in conjunction with the outdoor air temperature thermistor. It also serves as a calibration check on itself with the outdoor air thermistor.

The communicating controls continuously monitor and compare the sensed outdoor air temperature with the sensed outdoor coil temperature to ensure that they are operating within their designed range. For example, in the cooling mode if the sensed outdoor air temperature is 10°F or more warmer than the sensed coil temperature, or if the sensed outdoor air temperature is 20°F or more cooler than the sensed coil temperature, the sensors are out of range. In the heating mode if the sensed outdoor air temperature is 35°F or more warmer than the coil temperature sensed or if the sensed outdoor air temperature is 10°F or more cooler than the sensed coil temperature, the sensors are out of range. If the sensors are out of range, the control will flash fault code 56. The thermistor comparison is not performed during defrost operation.

When performing service on the OCT, check and note that it should be mounted to the tube connecting the EXV and the distributor, exactly as shown in this visual. The thermistor must be secured tightly on the tube. This is very important for the operation of this unit.

If the OCT should fail, or if a thermistor out-of-range fault occurs, defrost will occur at each time interval during heating operation, but it will terminate after 5 minutes. The control will flash fault code 55.

Electronic Expansion Valve (EXV)

HEAT PUMP ONLY

MODE	ELECTRONIC EXPANSION VALVE POSITION
Cooling	EXV is wide open
Heating Pre Set	Control board determines target position, depending on speed and ambient temperatures for 120-seconds
After Heating Pre Set	Control board controls EXV as needed to control suction superheat and/or compressor load
Defrost	EXV is wide open

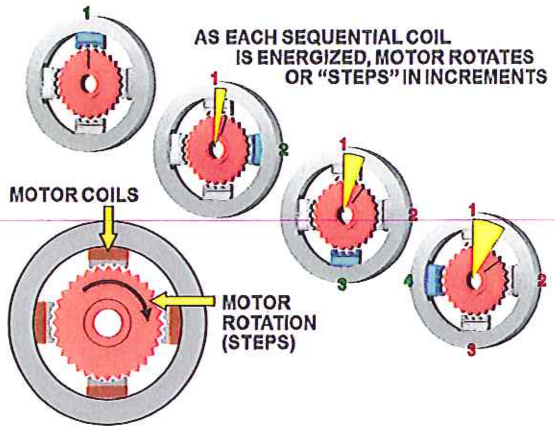
Unlike a thermal expansion valve (TXV) that operates on system pressures and temperatures, the EXV operates on an electronic command from the AOC board with pressure and temperature inputs. The internal operation of the EXV is similar to that of a TXV.

In a TXV, a needle valve moves in and out in relationship to an orifice in the internal body of the valve, thereby throttling the amount of refrigerant allowed through the valve. This opening is determined by the refrigerant temperature and refrigerant pressure. The operation of the EXV is the same; a needle valve moves in and out in relationship to an orifice in the body of the valve, throttling the amount of refrigerant that is allowed through the valve. The difference is that the EXV uses a tiny electric motor, called a stepper motor, to drive the needle valve in and out of the orifice. This is accomplished by the motor turning an inside threaded cylinder (the female screw) over a threaded shaft (the needle valve). The linear movement opens and closes the needle valve orifice.

From the factory, the unit is shipped with the EXV in the open position. At power-up, the AOC board resets the position of the EXV and sets the valve logic to close by attempting to over-close the valve. All open positions of the EXV during the heating, cooling and defrost cycle are derived from this closed position. When the heating, cooling or defrost cycle is terminated and the unit is turned off, the AOC board again attempts to over-close the EXV, then repositions it to a partially open position. There are a total of 480 steps of the stepper motor from the closed to the fully open position.

In the cooling mode, the control board controls the EXV to its fully open position. In the heating mode, the control board initially operates through a preset condition that closes the EXV to a target position that is dependent on the compressor speed and the outdoor air temperature. It maintains that target for 120 seconds. After it reaches the preset position, the control board controls the EXV as needed to control the suction superheat and/or the compressor load. During defrost, the control board modulates the EXV to its fully-open position. A check valve in parallel with the EXV ensures that it does not create any restriction during cooling mode operation.

Stepper Motor

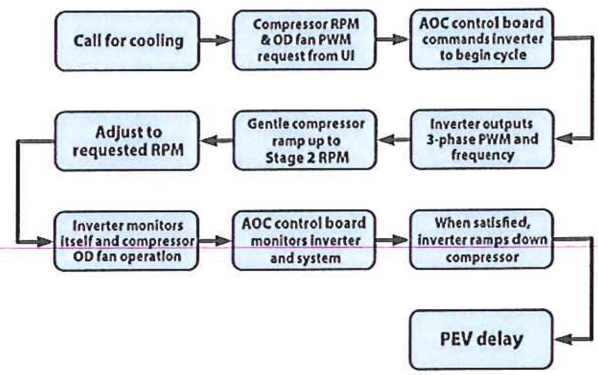


A stepper motor is a brushless, synchronous electric motor that can divide a full rotation into a large number of steps. The motor's position can be controlled without any feedback mechanism. Stepper motors operate differently from DC motors. Stepper motors have multiple toothed electromagnets arranged around a shaped iron gear. The electromagnets are energized by an external control circuit, which in our case is the AOC board. In our example, we will use four magnetic poles, an even number, and a gear with 25 teeth, an odd number, so that when the teeth are aligned with the first pole, they will be offset at the second pole.

To make the motor shaft turn, first one electromagnet is given power, which makes the gear's teeth magnetically attracted to the electromagnet's teeth. When the gear's teeth are thus aligned to the first electromagnet, at 1, they are slightly offset from the next electromagnet, at 2. When the next electromagnet, at 2, is turned on and the first is turned off, the gear rotates slightly to align with the gear at 2. The process is repeated because when the gear's teeth are aligned, at 2, they are slightly offset at 3. When the gear's teeth are aligned, at 3, they are slightly offset at 4. When the top electromagnet, at 1, is again enabled, the teeth in the sprocket will have rotated by one tooth position. Each of these slight rotations is called a "step." Since it took four steps to rotate the gear one tooth, and because our motor has 25 teeth, it will take 100 steps, four times the number of teeth, to make a full rotation.

Stepper motors emit a slight audible noise, as the discrete step tends to snap the rotor from one position to another, causing a vibration. This is because the rotor is being held in a magnetic field. On each step the rotor overshoots and bounces back and forth. This vibration is a benefit for service technician when troubleshooting, because they will be able to hear the stepper motor during operation. Conversely, it will be quiet if it is not operating when it should be.

AC Sequence of Operation



Upon a call for cooling through the UI (or the Y1 and/or Y2 connections in a non-communicating system), the AOC board will initiate a cooling cycle. Based on the indoor space demand and the outdoor conditions, the UI will request a compressor speed and outdoor fan motor speed. If the conditions are right for operation, the control board will allow the requested operation to begin, but if the control board determines that the conditions are not correct, the board will decide what other operation nearing that condition is acceptable.

The VSD MOC then outputs the three-phase PWM signal and frequency that gently ramps the compressor speed up to stage 2, and then will adjust to the demanded speed. The gentle ramp-up results in no locked rotor amps to the compressor motor. The unit nameplate for compressor LRA will be stamped N/A (not applicable).

During cooling operation, the AOC monitors itself and the compressor operation, along with the system pressures and temperatures. The MOC board monitors the temperature, current and operational status of the compressor, OD fan and the VSD itself. During cooling operation, the compressor speed will be adjusted to meet the changes to the demand for cooling.

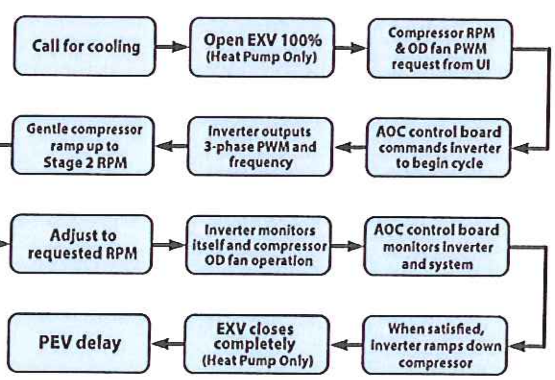
When the cooling demand is satisfied, the VSD will ramp-down the compressor speed and stop. When the compressor stops, after each compressor ON cycle, a 3.5 minute TimeGuard period is activated which is followed opening of the PEV valve for 150 seconds to equalize the refrigerant pressure difference between the high and low sides of the compressor. Upon equalizing the pressures, and an additional 30 seconds of protection period the compressor will be ready for the next operational demand. If however there is a power cycle, the PEV valve will open for 150 seconds before the compressor start up. Opening the PEV valve returns the discharge gas directly back to the suction side of the compressor. This is done so that the rotary compressor will start with a very low pressure differential. The 3.5 minute TimeGuard can be bypassed by the UI (or with a non-communicating control) by momentarily shorting the Forced Defrost pins. Again, only the 3.5 minute time delay can be bypassed. Because it is important for compressor reliability, the 150 second PEV delay can not be bypassed.

During the OFF cycle, depending on the length of an OFF cycle, the compressor will occasionally be energized to start the stator heating operation, thus maintaining a sump temperature that is essential for compressor reliability.

Stage	2T Compressor RPM	3T Compressor RPM	4T Compressor RPM	5T Compressor RPM
1	1200	1200	1500	1200
2	1900	2400	2460	2180
3	2400	3300	2800	2850
4	2600	4200	3650	3700
5	3300	4800	4320	4140

This table shows the cooling operational stages. Depending on the suitability and reliability of the system operation, not all stages will be made available at all ambient conditions.

HP Cooling – Sequence of Operation



Upon a call for cooling through the UI (or the Y1 and/or Y2 connections in a non-communicating system), the AOC board will open the EXV to the fully open position. Then, based on the indoor space demand and the outdoor conditions, the UI will request a compressor speed and outdoor fan motor speed. If the conditions are right for operation, the control board will allow the requested operation to begin, but if the control board determines that the conditions are not correct, the board will decide what other operation nearing that condition is acceptable.

The VSD MOC then outputs the three-phase PWM signal and frequency that gently ramps the compressor speed up to stage 2, and then will adjust to the demanded speed. The gentle ramp-up results in no locked rotor amps to the compressor motor. The unit nameplate for compressor LRA will be stamped N/A (not applicable).

During cooling operation, the AOC monitors itself and the compressor operation, along with the system pressures and temperatures. The MOC board monitors the temperature, current and operational status of the compressor, OD fan and the VSD itself. During cooling operation, the compressor speed will be adjusted to meet the changes to the demand for cooling.

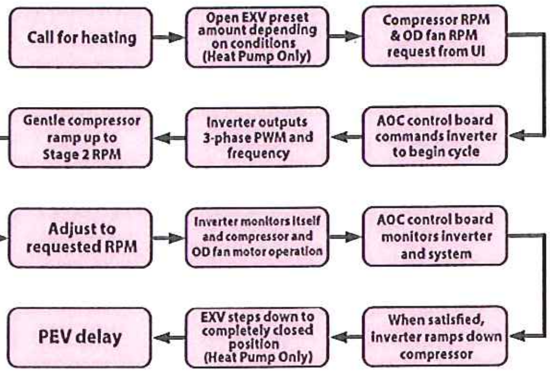
When the cooling demand is satisfied, the VSD will ramp-down the compressor speed and stop. The EXV will step down to the completely closed position. When the compressor stops, after each compressor ON cycle, a 3.5 minute TimeGuard period is activated which is followed opening of the PEV valve for 150 seconds to equalize the refrigerant pressure difference between the high and low sides of the compressor. Upon equalizing the pressures, and an additional 30 seconds of protection period the compressor will be ready for the next operational demand. If however there is a power cycle, the PEV valve will open for 150 seconds before the compressor start up. Opening the PEV valve returns the discharge gas directly back to the suction side of the compressor. This is done in either cooling or heating mode so that the rotary compressor will start with a very low pressure differential. The 3.5 minute TimeGuard can be bypassed by the UI (or with a non-communicating control) by momentarily shorting the Forced Defrost pins. Again, only the 3.5 minute time delay can be bypassed. Because it is important for compressor reliability, the 150 second PEV delay cannot be bypassed.

During the OFF cycle, depending on the length of an OFF cycle, the compressor will occasionally be energized to start the stator heating operation, thus maintaining a sump temperature that is essential for compressor reliability.

Stage	2T Compressor RPM	3T Compressor RPM	4T Compressor RPM	5T Compressor RPM
1	1200	1200	1500	1200
2	1900	2400	2460	2180
3	2400	3300	2800	2850
4	2600	4200	3650	3700
5	3300	4800	4320	4140

This table shows the cooling operational stages. Depending on the suitability and reliability of the system operation, not all stages will be made available at all ambient conditions.

HP Heating – Sequence of Operation



Upon a call for heating through the UI (or the Y1 and/or the Y2 in a non-communicating system), the AOC board will open the EXV to a preset position, depending upon the conditions. Then, based on the indoor space demand and the outdoor conditions, the UI or the thermostat will request a compressor speed and outdoor fan motor speed. If the conditions are right for operation, the control board will allow the requested operation to begin. If the control board determines that the conditions are not correct, however, the board will decide what other operation for that condition is acceptable.

The VSD then outputs the three-phase PWM signal and frequency, which gently ramps the compressor speed up to stage 2, then will adjust to the demanded speed. The gentle ramp-up will result in no locked rotor amps to the compressor motor. The unit nameplate for compressor LRA will be stamped N/A (not applicable).

During heating operation, the MOC monitors itself, along with compressor and fan motor operation, while the AOC board monitors the MOC along with the system pressures and temperatures. During heating operation, the compressor speed will be adjusted to meet the changes to the demand for heating.

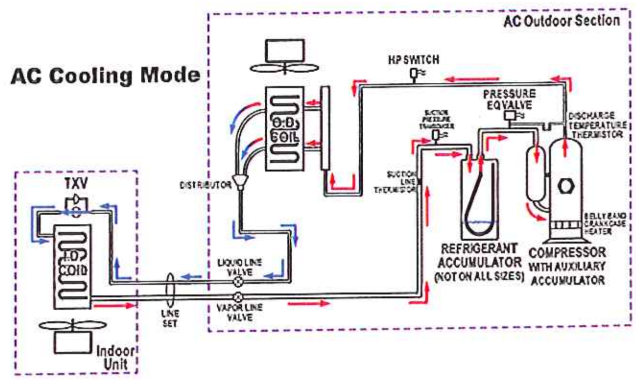
When the heating demand is satisfied, the MOC will ramp-down the compressor speed and then stop. The EXV will step down to the completely closed position. Also when the compressor stops, after each compressor ON cycle, a 3.5 minute TimeGuard period is activated which is followed opening of the PEV valve for 150 seconds to equalize the refrigerant pressure difference between the high and low sides of the compressor. Upon equalizing the pressures, and an additional 30 seconds of protection period the compressor will be ready for the next operational demand. If however there is a power cycle, the PEV valve will open for 150 seconds before the compressor start up.

During the off-cycle, depending on the length of an off-cycle, the compressor will be energized, thus allowing the stator heater operation if conditions require.

Stage	2T Compressor RPM	3T Compressor RPM	4T Compressor RPM	5T Compressor RPM
1	1200	1200	1500	1200
2	2400	2600	2800	2600
3	2400	3400	3300	3200
4	4200	4800	4320	4140
5	4800	5400	5400	5400

This table shows the operationally possible heating stages and respective compressor RPMs. Not all stages are operational at all ambient temperatures due to reliability and system performance concerns.

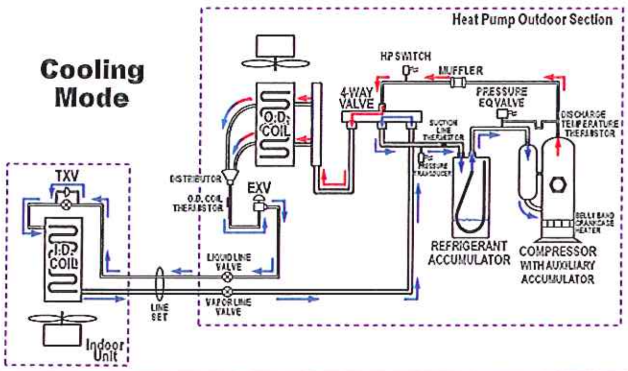
AC Refrigerant Management



In the cooling mode, the hot refrigerant gas enters the outdoor coil, where the gas condenses and exits through the feeder tubes. The liquid refrigerant will then move through the liquid service valve and through the liquid tubing to the TXV of the indoor coil. While passing through the TXV, and having been subjected to the expansion process, the refrigerant will cool and subsequently evaporate inside the indoor coil while absorbing the heat from indoor air. The refrigerant vapor will return to the outdoor unit through the suction tube into the accumulator and through the accumulator tube back to the compressor.

Note however, after each compressor ON cycle, a 3.5 minute TimeGuard period is activated which is followed by opening the PEV valve for 150 seconds to equalize the refrigerant pressure difference between the high and low sides of the compressor. Upon equalizing the pressures, and an additional 30 seconds of protection period the compressor will be ready for the next cooling demand. If however there is a power cycle, the PEV will open for 150 seconds before the compressor can start up. A hissing sound may be head during the equalization process; this is normal.

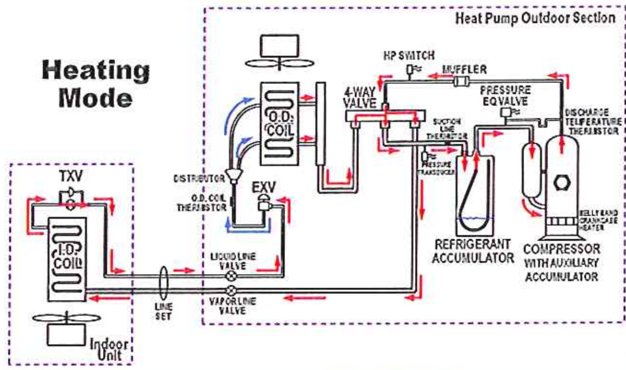
HP Refrigerant Management – Cooling Mode



In the cooling mode, the hot refrigerant gas enters the outdoor coil, where the gas condenses and exits through the distributor feeder tubes and refrigerant distributor into the EXV assembly. It is bypassed through the check valve, as well as the wide open EXV. The liquid refrigerant will then move through the liquid service valve and through the liquid tubing to the TXV of the indoor coil. While passing through the TXV, and having been subjected to the expansion process, the refrigerant will cool and subsequently evaporate inside the indoor coil while absorbing the heat from indoor air. The refrigerant vapor will return to the outdoor unit through the reversing valve and gets directed through the suction tube into the accumulator and through the accumulator tube back to the compressor.

Note however, after each compressor ON cycle, a 3.5 minute TimeGuard period is activated which is followed by opening the PEV valve for 150 seconds to equalize the refrigerant pressure difference between the high and low sides of the compressor. Upon equalizing the pressures, and an additional 30 seconds of protection period the compressor will be ready for the next cooling demand. If however there is a power cycle, the PEV will open for 150 seconds before the compressor can start up. A hissing sound may be heard during the equalization process; this is normal.

HP Refrigerant Management – Heating Mode



The refrigerant hot gas leaves the compressor through the discharge tube, entering the reversing valve which directs the refrigerant to the indoor unit coil header. The heated refrigerant provides heat to the indoor air circulating over the indoor coil and is then returned to the outdoor unit as a liquid. The indoor unit contains a TXV that is used in the cooling mode. It has a built-in bypass for the heating mode. The refrigerant exits the indoor coil through the bypass in the TXV.

The liquid enters the EXV, which throttles the refrigerant based on the unit load. The refrigerant leaving the EXV passes through the refrigerant distributor and feeder tubes, and then through the outdoor coil.

The cold refrigerant vapor exiting the outdoor coil, which in this case is acting as an evaporator, is then directed by the reversing valve into the accumulator and back to the compressor.

Note however, after each compressor ON cycle, a 3.5 minute TimeGuard period is activated which is followed by opening the PEV valve for 150 seconds to equalize the refrigerant pressure difference between the high and low sides of the compressor. Upon equalizing the pressures, and an additional 30 seconds of protection period the compressor will be ready for the next heating demand. If however there is a power cycle, the PEV will open for 150 seconds before the compressor can start up. A hissing sound may be heard during the equalization process; this is normal.

Controls, System Setup, and Checkout

In this section of this program, you will be introduced to the communicating controls used with this system. We will cover the process that the communicating control goes through upon start-up, as well as the parameters that both the homeowner and the technician can set during the commissioning of the system.

NOTE: More detailed information about the Infinity® Touch Controls is provided in a separate training program.

Overview

One user interface per installation

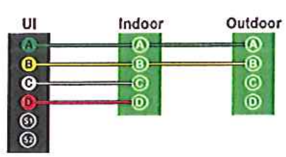
- Non-zoned system:
  - Measures room temperature
  - Senses humidity
- Zoned system:
  - Typically located in Zone 1 to sense space temperature and humidity
  - May use only as system interface
    - Then Zone 1 space temperature sensed by:
      - Remote Room Sensor (RRS) or Smart Sensor (SS)
    - RRS or SS in Zones 2 to 8

The building occupant controls the communicating controls with a wall-mounted user interface (UI) control. The UI control is used to send instructions to the microprocessor control board located in the indoor and outdoor units. Each installation may have only one UI.

User Interface Overview

User interface required for this system:

- Communicating ABCD from UI to indoor unit
- Only A and B required from UI or indoor unit to outdoor unit

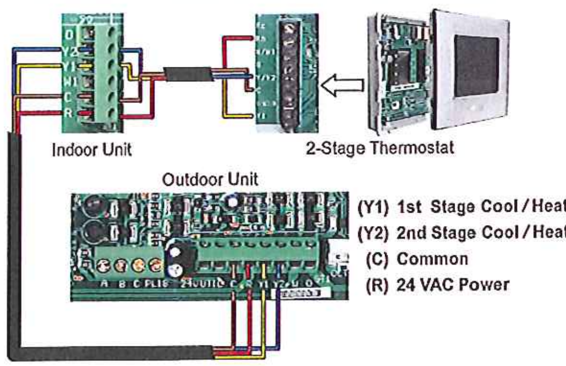


A fully communicating system requires ABCD communication bus wiring between the communicating controls (UI) and the system's indoor equipment. AB wiring is required between indoor and outdoor equipment components.

In addition to controlling indoor temperature for these systems, the communicating controls provide features that include the ability to humidify, dehumidify, control ventilation air, and provide system diagnostics. The communicating controls provide dirty-filter detection; establishes relative duct size in a zoning system; and notifies the user when maintenance is required. Many of the above features rely on direct communication between the communicating controls and the indoor unit and blower motor through the ABCD bus. Versions of the communicating controls are WiFi-enabled to support features like weather, over-the-air software updates, and remote access.

Non-Communicating Thermostat Connections (AC)

AC NON-COMMUNICATING MODE WIRING

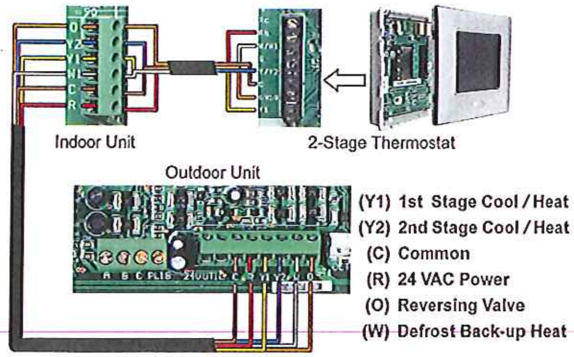


The communicating controls provide the most functionality and normally perform thermostat functions for the system. However, even after the system has been configured with the communicating controls, the indoor and outdoor units can be made to work with a non-communicating thermostat. The connections are slightly different between an air conditioning unit and a heat pump unit.

For an air conditioning unit a two stage cooling thermostat is used. The thermostat is connected from the thermostat to the indoor unit control board and from the indoor unit to the AOC board in the outdoor unit. This is done by connecting the Y1 (first stage cooling, Y2 (second stage cooling) C (common) and R (24 Volt power) between the units using the appropriate terminal connections on each board.

Non-Communicating Thermostat Connections (HP)

HP NON-COMMUNICATING MODE WIRING



The heat pump unit is connected in a similar manner between the room thermostat, indoor control board and the unit AOC board. The connections on the heat pump also include connections to the W (backup heat) and the O (reversing valve).

Infinity® Touch

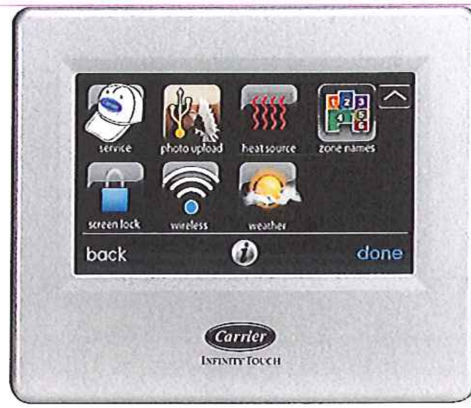
The communicating controls have touch-screen displays. The display shows the current zone or room temperature, set points, mode, activity, time and date, along with a feature drop-down menu and a menu button.

One can navigate through the display screens to see operational information and menu choices.

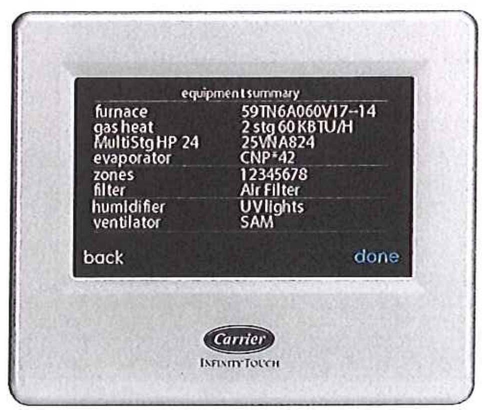
The communicating controls support either a non-zoned or zoned system, depending on whether a zoning board had been learned automatically during installation.

Menu Options

To better help you understand the approach that we will be taking in navigating through the display screens, the first and second menu screens are shown here.



System Setup



First, when power is applied to the communicating controls for the very first time, several information-only screens will be displayed. When the communicating controls pause, you will be asked to input information identifying equipment that may or may not be installed in the system. If the indoor unit is a fan coil with a service board, the fan coil type must be selected.

The outdoor unit should automatically identify when the wall control is searching for the outdoor unit. If the outdoor unit is not properly communicating on the bus to the wall control, the wall control will indicate that no outdoor unit is found and will request a selection. At this point the connections and wiring should be checked.

After the indoor unit, outdoor unit, evaporator coil, electric heater, system access module (SAM), and zoning have either been discovered or detected; the communicating controls will request that the technician select several accessories, such as the air filter type or UV lights. The accessories will have to be identified, since it is not possible for the system to self-identify these installed accessories. When the learning process finishes, the equipment summary screen will appear.

Service Screen

The service screen is very comprehensive and access is intended only for the service technician. By pressing and holding the "SERVICE" button for at least 10 seconds until it turns green, a technician can access the service and setup features. These displays include viewing the summary of equipment that is installed in the system; installing and/or removing equipment; setting up the different equipment in the system; performing checkout tests on the equipment; and accessing service information.

Cooling Setup

The Setup Cooling screen allows selection of the preferred maximum and minimum stages in cooling. The minimum cooling stage acts like a high-cool latch. In cooling, the minimum stage at which the system will run is in effect when the outdoor temperature is above the selected "LATCH ABOVE" temperature. If the outdoor air temperature is warmer than the setting on this screen, the minimum stage will be as selected.

The currently available stages vary with outdoor air temperature and the system will have a reduced set of available stages. If there is no overlap between the range of preferred stages and the range of currently available stage, the system should still be able to run a stage. In the case of no overlap, if the maximum currently available stage is less than the minimum preferred stage, the maximum available stage will be the only operational stage. Likewise, if the minimum currently available stage is greater than the maximum preferred stage, the minimum available stage will be the only operational stage.

The minimum cooling stage is dependent on outdoor air temperature, but may apply for all outdoor temperatures, if "ALWAYS" is selected. When satisfied with the selections, touch "SAVE" when done.

Heat Pump Setup

From the Service screen, touching either the "COOLING" or "HEATING" next to "STAGES/LATCH" will send the technician to the Setup Cooling screen or Setup Heating screen, as applicable.

The "cooling lockout" is the outdoor air temperature that can be set to prevent operation of the outdoor unit below that temperature. The selections are NONE (the factory default), 45, 50 or, 55° F.

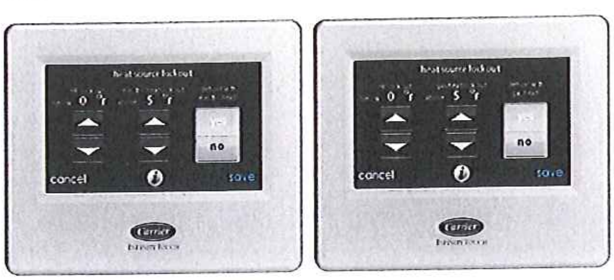
The "DEFROST INTERVAL" is the time the system waits to check for the need to defrost. The selectable intervals are 30, 60, 90, 120 and AUTO. AUTO is the ideal defrost selection because it is an intelligent defrost interval selection made by the communicating controls. AUTO is the default setting used with a communicating control heat pump.

The feature "LOW AMBIENT COOL" is not available for this configuration, and is grayed out.

Heating Setup

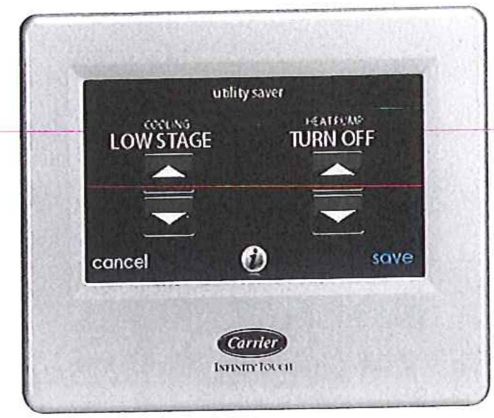
In heating, the SETUP HEATING screen allows the preferred maximum and minimum stages in heating. The minimum heating stage acts like a high heat latch. In heating, the minimum stage at which the system will run is in effect when the outdoor temperature is below the selected "LATCH BELOW" temperature. If the outdoor air temperature is colder than the setting on this screen, the minimum stage will be in effect.

Heat Source Lockout



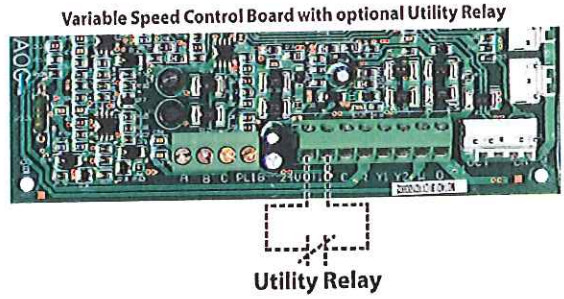
The "HP LOCKOUT" is the outdoor air temperature that can be set to prevent operation of the outdoor unit below that temperature. The selections are NONE (the factory default), and a range of -20°F through 55°F, in 5°F intervals. "GAS HEAT LOCKOUT" or "ELECTRIC HEAT HEATING LOCKOUT" is the outdoor air temperature that can be set to prevent operation of the outdoor unit above that temperature. The selections are NONE (the factory default), and -20°F through 55°F, in 5°F intervals. Running the electric heat or the furnace during defrost is a selectable option.

Utility Curtailment



The Utility Curtailment feature is available for the system. This function allows the utility company to restrict operation during peak energy demand periods. A signal sent from the power company to the utility curtailment switch supplied by the local utility is passed to the wall control, which will respond by restricting system operation.

Variable Speed Control Board with optional Utility Relay



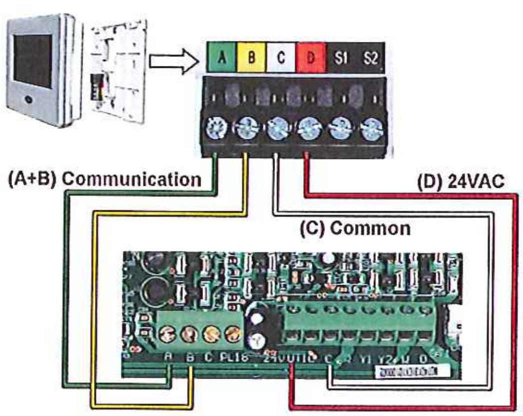
Three selections are available: DISABLED, TURN_OFF, and LOW_STAGE. DISABLED does not allow the utility curtailment signal to have an effect on staging. TURN_OFF keeps the unit off when the utility curtailment signal is active. LOW_STAGE restricts the unit to a maximum of the first stage when the utility curtailment signal is active.

Checkout

As part of the special service screens, the "CHECKOUT" feature allows the service technician to perform various tests on the unit, as well as some of the components used in the unit. While running the system at a given stage for a desired time, the technician will also be able to see temperatures, pressures and speeds for proper operation.

By holding down the "SERVICE" icon for at least 10 seconds and waiting until the icon is highlighted green, the technician can access the service menu and select the checkout mode for either heat pump heating or heat pump cooling. The desired stage and time to run the stage are selectable.

Service Tool



When working on the outdoor unit of a split system, the technician would usually need to repeatedly walk between the indoor wall control and the outdoor unit. To save time, the communicating controls offer a service tool feature. By wiring the service tool into the AOC board, the technician can have a wall control capable of running the system right at the outdoor unit.

To use a service tool, connect the A and B communication bus wires from this second communicating control to the terminals marked A and B on the terminal strip located in the bottom left corner of the AOC board. But instead of connecting the wires on the service tool to the terminals marked C and D, connect the C wire from the service tool to the terminal strip to the right of the ABCD terminal strip at the terminal marked C. Connect the D wire from the service tool to the terminal marked UT, the far left terminal, on the same terminal strip to which the wire from the C terminal was connected.

When the service tool is connected and powered up, the communicating controls inside the home will "go to sleep" and let the service tool take control of the system. In this manner, the service technician can run the diagnostic checkouts right at the outdoor unit using the service tool.

After the checkouts are completed and it is no longer necessary to use the service tool, remove it from the communicating controls and the indoor communicating controls will regain control in about two minutes.

Heat Pump Heating Check

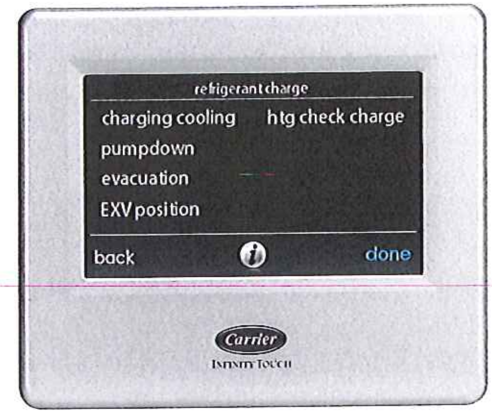
When heating checkout of the heat pump is performed, checkout will operate for a minimum time of 5 minutes to allow conditions to stabilize. However, if it is determined that a 5-minute time will not be long enough, this time can be increased up to 120 minutes. A defrost cycle is also selectable with a 5-minute operational time. During checkout, the heat pump airflow checks are performed in the EFFICIENCY mode. If airflows need to be checked in other modes, the heat pump must be placed into operation with a heating demand.

AC/HP Cooling Check

When cooling checkout of the air conditioner or heat pump is performed, the cooling checkout function will operate for a minimum time of 5 minutes to allow conditions to stabilize. However, if it is determined that a 5-minute time will not be long enough, this time can be increased up to 120 minutes. The heat pump or air conditioner can also be operated at any stage allowed by the system at the current outdoor air temperature conditions. Like the heat pump heating checkout, during air conditioner or heat pump cooling checkout, the air conditioner or heat pump airflow checks are performed in the EFFICIENCY mode.

If other airflows need to be checked in other modes, the air conditioner or heat pump must be placed into operation with a cooling demand.

Refrigerant Charging Check



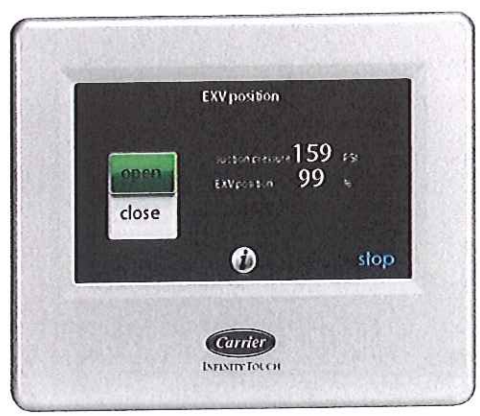
The charging will allow the three options of refrigerant charging; weight calculation, charging via subcooling in the cooling mode, or heating check charge. The subcooling option may be greyed out if the conditions are not favorable. Favorable charging conditions exist when the outdoor air temperature is between 65°F and 100°F, and the indoor air temperature is between 70°F and 80°F. If the temperatures are outside of these ranges, the charge must be weighed in.

Refrigerant Pump-Down Check

At times it may be necessary to isolate the refrigerant in the outdoor coil in order to break into the refrigeration system. In this case, the unit can be operated in cooling to contain the refrigerant in the outdoor coil. A pump-down option is available for this purpose. Start the pump-down procedure and then close the liquid line service valve. The system will display several parameters that are helpful to observe. As the suction pressure drops, the suction pressure transducer should be ignored. At the conclusion of the pump-down check, close the vapor valve on the unit to store the refrigerant in the outdoor coil.

Evacuation and EXV Check

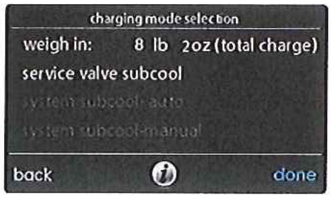
On Heat pump units when the evacuation and EXV check (EVAC AND EXV CHECK) is displayed, the EXV can be forced open (OPEN) or forced closed (CLOSED). This check is performed in the OFF mode and the EXV will exhibit a small amount of chatter because of the motor steps. The technician can verify audibly that the EXV "appears" to be opening and closing. Although the EXV can be heard to be moving, a stuck EXV that cannot move will also exhibit a small amount of chatter. Further diagnosis, as explained in the Troubleshooting section, may have to be performed to verify that the valve is indeed opening and closing.



To assist in refrigerant charge evacuation, the EXV can be driven open to efficiently evacuate the system.

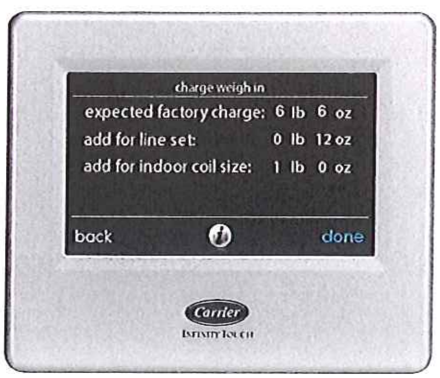
Refrigerant Charge Calculation

The refrigerant charging calculation takes into account the sizes and type of the indoor evaporator or fan coil, size of the outdoor unit, and the size (diameter and length) of the vapor line between the indoor and outdoor units. The liquid line size must be 3/8-inch OD. If the liquid line and vapor line are different lengths, use the liquid line length as the vapor line length.



In order to check the refrigerant charge, the technician will have to select the actual line set length and the vapor line diameter to match the installed system. The technician would set the vapor line size for a length of 35 feet and a diameter of 5/8-inch in our example.

The CHARGE WEIGH IN calculation display can be used as a quick and easy means of determining the amount of refrigerant to charge into the system either at initial installation or when it has been necessary to recover the charge in order to open the system. To bring up the calculation, touch the WEIGH IN selection on the CHARGING MODE SELECTION screen. This charge calculation should also be used when charge cannot be added during the cooling mode. Remember, the system was pre-charged for a 15-foot line set and a 5/8-inch vapor line. Because we have a 35-foot line, there isn't enough refrigerant in the system.



The system performs the calculation and, for our example, the system is telling the technician that the original factory charge on this unit was 6.0 lb, 6.0 oz and, because of our longer line set, 12 oz of refrigerant must be added. Also, the indoor coil will require additional refrigerant of 1 lb. This will leave a total charge in the system of 8 lb, 2 oz.

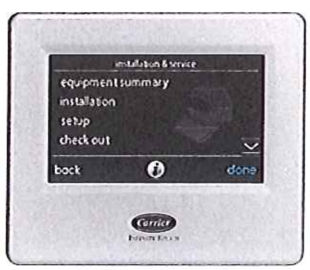
The SERVICE VALVE SUBCOOLING selection will be available if the conditions are favorable. Favorable charging conditions exist when the outdoor air temperature is between 65°F and 100°F, and the indoor air temperature is between 70°F and 80°F. If the temperatures are outside of these ranges, the charge must be weighed in. If charge confirmation is required, return and check the subcooling when the temperatures are within the desired range. Refrigerant charge can only be added during the cooling cycle.

Unit Service

In the Service section of this program, we will cover the helpful tools built into the communicating controls to assist the service technician in diagnosing some of the problems that occur during unit operation. We will also cover some of the service requirements unique to this type of equipment.

The SERVICE function of the communicating controls is specifically for the service technician to set the parameters of the UI. Unlike the other menu items, to access this menu, the technician must touch and hold the SERVICE symbol for ten seconds.

Service Menus



The SERVICE menus include EQUIPMENT SUMMARY, INSTALLATION, SETUP, CHECK OUT, SERVICE INFORMATION, REFRIGERANT CHARGING, SOFTWARE UPGRADE, and DEALER LOGO UPLOAD.

System Malfunction

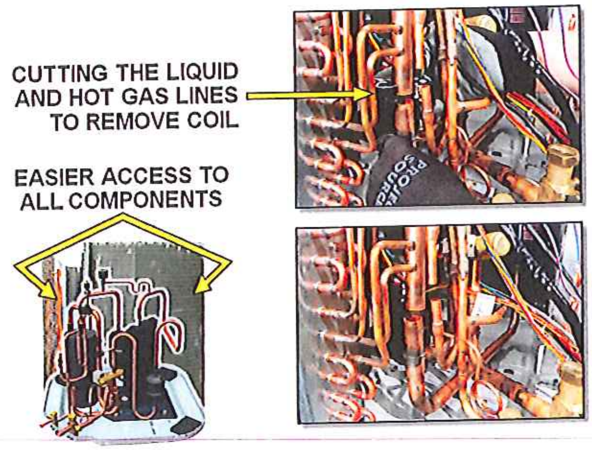
- Screen shows after a malfunction
- May clear on its own
- Check if it reoccurs
- Caused by specific fault codes
- RESETABLE FAULTS clears system
- Determine fault by accessing:
  - SERVICE MENU
  - SERVICE INFORMATION
  - FAULT RUN/FAULT HISTORY

Certain system events can result in the pop-up message SYSTEM MALFUNCTION. A system malfunction is an event that could be related to a failed component, or an event that may not necessarily indicate an equipment problem. If this message clears on its own and the equipment operates normally, it can be ignored. This was most likely caused by a temporary condition which has been corrected. If it does not clear, or comes back repeatedly after being dismissed, the system should be checked as soon as possible. The SYSTEM MALFUNCTION message is only caused by specific fault codes; not all fault codes will result in a SYSTEM MALFUNCTION message.

The technician can touch and hold the SERVICE symbol to get the SERVICE INFORMATION screen and then touch RUN/FAULT HISTORY. The next screen layer will display RESETABLE FAULTS. Touching RESETABLE FAULTS will clear the system of the fault. If the error has not disappeared within the next 24 hours, the above display will return. If the error code disappears, SYSTEM MALFUNCTION will disappear.

This message may be generated from any of the communicating system components, and will be displayed as shown.

Replacing Components



The condenser coil of the unit wraps around all four sides of the unit, with the exception of the VSD and control box locations. The condenser coil is also higher than some units, making it difficult to replace some components by removing the unit's outdoor fan motor and unit top cover and fan guard. To replace components like the compressor, reversing valve and EXV, for example, the removal of the condenser coil will likely be required to gain adequate access to these and possibly other components.

Replacement of the compressor, reversing valve, EXV and some other components will require the refrigerant lines to be cut. Therefore, the refrigerant charge will have to be recovered so the condenser coil can be removed. To remove the condenser coil from the unit, it is recommended that the liquid line be cut just below the refrigerant distributor and the vapor line be cut just below the coil header as shown.

Removing the condenser coil to gain access to components will allow the service technician to actually save time in making changes in the refrigeration system. Because all of the components will be readily accessible, the work performed can actually be neater and cleaner than it would be if trying to reach difficult to access components without removing the coil. Failure to remove the condenser coil risks damaging the coil as well as putting technicians into unsafe situations.

Servicing Procedures

This family of variable speed air conditioners and heat pumps can be serviced like any other air conditioning or heat pump unit using Puron® refrigerant. Pressures in these units are higher than older R-22 units and handling any refrigerant can be harmful, always follow proper safety precautions.

When servicing the refrigerant system, which is under pressure, always wear gloves and safety glasses.

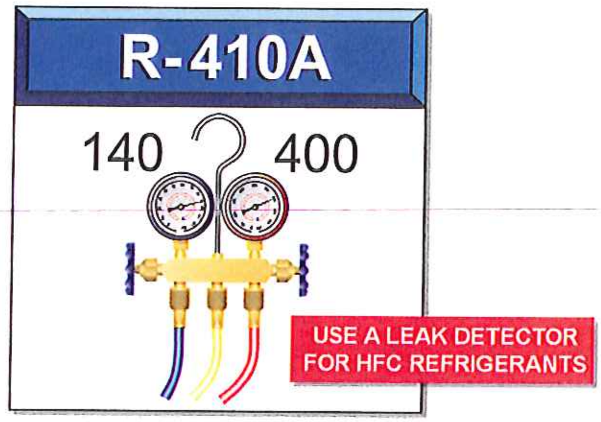
Puron® Refrigerant

ONLY CHARGE WITH LIQUID (TANK INVERTED)

uron® refrigerant, also known as R-410A, is the refriger-
nt used in most residential split systems today. R-410A
efrigerant is an HFC and does not contain any ozone-de-
leting chlorine. The operating pressures of Puron®
efrigerant are higher than older R-22 units, so the appro-
riate service equipment should be used. The compressor
ubricating oil is a POE (polyolester) type and requires
ome specific service procedures to protect the system
rom moisture infiltration.

ince Puron® refrigerant is a "near" azeotropic refrigerant;
ll products using Puron® must be charged with liquid. All
r as much of the charge as possible should be "dumped" into the high side of the system after a 500-micron vacuum is obtained. Any remaining refrigerant should be charged as a liquid, through a flow-restricting device, into the suction side of the system with the compressor running.

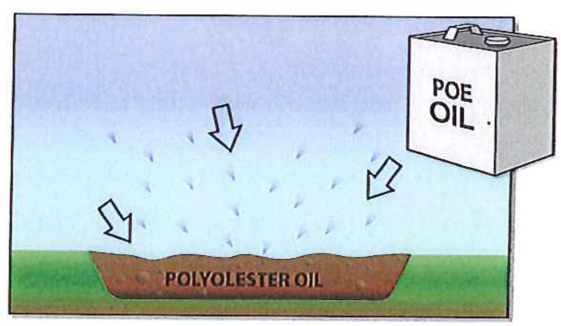
Typical Operating Pressures



The operating pressures for Puron® refrigerant --(typically suction pressures of 140 psi and discharge pressures of 400 psi) require the use of a high-pressure gauge manifold and high-pressure hoses. When recovering refrigerant, use a recovery machine and recovery tank rated for the R-410A refrigerant.

Since Puron® refrigerant does not contain chlorine, many old style leak detectors cannot be used to detect R-410A refrigerant leaks. Whenever checking for leaks, make sure the leak detector is capable of detecting HFC refrigerants.

Polyolester (POE) Lubricating Oil



Puron® Refrigerant units contain a polyolester (POE) lubricating oil. This oil readily absorbs moisture from the air.

Puron® units contain polyolester (POE) lubricating oil. This oil is very hydroscopic, meaning that it readily absorbs moisture from the air. Water or moisture in sealed refrigerant systems causes many harmful side effects such as breakdown of the compressor oil and deterioration of compressor motor windings. This will lead to acid and sludge formation in the system. Clearly, moisture or moisture-contaminated oil must not be allowed into the sealed system. If contamination is expected the system should be checked using a test kit such as Total Test available from your Carrier distributor.

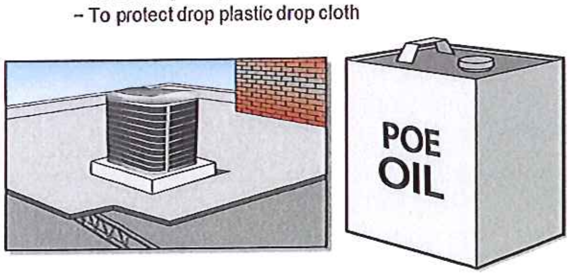
Storing POE oil in the wrong container can also cause it to absorb moisture. Never store POE oil in plastic containers; always use metal containers appropriately marked to indicate contents.

If the sealed system is opened for a service procedure such as replacing a compressor, moisture may enter. Moisture that has not been absorbed by the POE oil can be removed using the deep vacuum (500-micron) method. If the system has been open for an extended period, it can be assumed that the POE oil has absorbed moisture. The only way to remove moisture from the oil is to add a factory-approved Puron®-rated liquid line filter-drier, let the system run for 24 to 48 hours then change the filter drier again. Evacuation will not remove moisture from POE oil. DO NOT use filter-driers designed for use with other refrigerants. These filter-driers contain filtering material that can contaminate a Puron® refrigerant system.

Protect Roof from POE Oil Spills

To protect roof during service:

- Cover roof in work area with plastic (poly) drop cloth
- Cover area in front of service access panel with absorbent cloths
  - To soak up oil spills
  - To protect drop plastic drop cloth

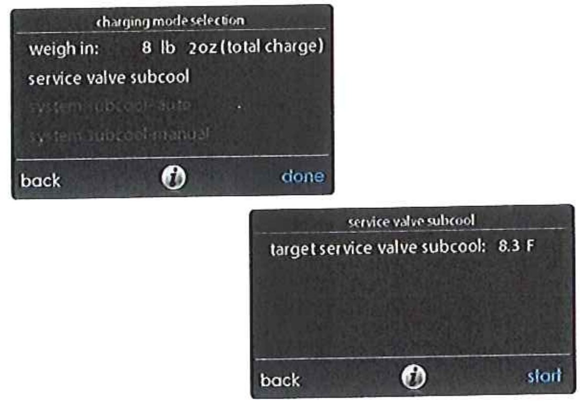


The POE oil in Puron® products can cause skin irritation. Wear safety glasses and gloves when working with Puron® refrigerant. Wash any exposed skin with soap and water to remove the oil.

POE oil can damage rubberized or synthetic membrane roofing materials. Even if an oil spill is immediately cleaned up, the exposure to oil is enough to trigger a slow deterioration of the roof. To prevent this damage, roofs must be protected during any service procedure where the chance of an oil spill is present. Follow these steps to protect the roof.

Cover the roof in the work area with a 10' x 10' polyethylene (plastic) drop cloth. Cover an area in front of the service access panel with absorbent cloths to soak up oil spills and to protect the drop cloth from damage.

Refrigerant Charging



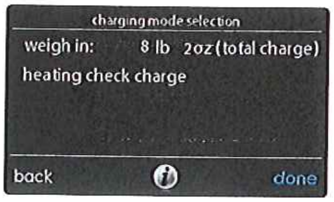
Charging can only be performed in the cooling mode and only using liquid refrigerant. Unit refrigerant charging is accomplished with the use of the UI. This is accessed on the UI by going to the SERVICE MENU and then to the REFRIGERANT CHARGING screen. Remember to set the lineset length to the application being serviced as well as the correct vapor line diameter. First, make sure there is a surface probe temperature measuring device on the liquid line and a gauge manifold on the liquid and suction ports.

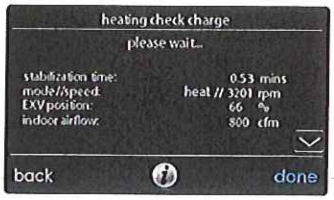
The system will measure the outdoor ambient temperature and display a subcooling target for the temperature and system configuration. In this example, the temperature and pressure measurements should equate to 8.3°F target subcooling. If the subcooling is lower, add charge until 8.3°F sub-cooling is achieved. Tolerance on the sub-cooling temperature is ±2°F. If any adjustment is necessary, adjust the charge slowly, no greater than 1/2-lb per minute, and allow the system to operate for 15 minutes for stabilization to achieve a proper charge.

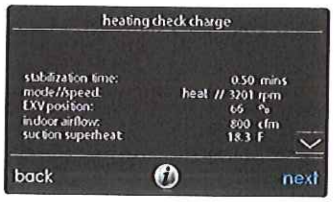
Monitor the subcooling and when the desired subcooling is achieved, stop adding charge. Charging hoses do not have to be routed through holes, since the service valve charging ports are readily accessible. Add or remove refrigerant charge slowly, about 1/2 lb. per minute. Allow the unit to operate for about 25 minutes so temperatures and pressures can stabilize before checking the charge. If charge is added, allow an additional 15 minutes after adding the charge so that the system pressures can stabilize again.

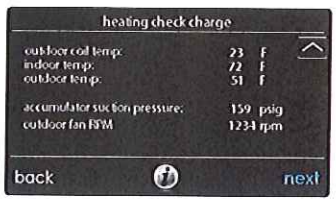
The use of a commercial charge metering device restrictor, such as Imperial liquid low side charger model 535-C or Watsco ChargeFaster™ model CH-200 is recommended when adding refrigerant to an operating system.

Refrigerant Heating Check Charge (Heat Pump Only)









The refrigerant charge can be checked in the heating mode via the HEATING CHECK CHARGE option on the UI. Select this option by touching REFRIGERANT CHARGING the screen and then HEATING CHECK CHARGE. Attach the manifold gages as in the cooling charging procedure. The unit will operate with a stabilization timer displayed on the UI screen. When the timer reaches stabilization, the system pressures can be compared versus the heating check label that is attached to the inside of the control box cover. Do not use this method to adjust the refrigerant charge in the heating mode. The weigh in method is the only way to adjust the charge in the heating mode. If it is determined that a heat pump operating in the heating mode is low on charge, first find the leak. Then recover the charge, repair the leak, evacuate the system to 500 microns, and weigh in the refrigerant amount displayed on the UI CHARGE WEIGH IN display.

Maintenance

There are some areas that require frequent checking. Indoor air filters, for example, can build up dirt, especially in a dusty environment or when high efficiency filters are used. Some areas require checking less frequently but cannot wait for an annual check or a beginning of season check. Other areas only require checking at the beginning of the heating or cooling season.

At the Beginning of Each Season

AT THE BEGINNING OF EACH SEASON:

1. Check coils for debris
2. Check indoor air filter
3. Check all electrical connections
4. Check refrigerant charge
5. Check outdoor coil thermistor
6. Check suction line thermistor
7. Check all refrigerant joints and valves for leaks
8. Check all fans and motors and clean blower wheel
9. Check indoor coil, drain pan, and trap
10. Check filter drier pressure drop
11. Check heater operation

At the beginning of each heating and cooling seasons the following system checks should be performed:

- Check coils for debris and clean as necessary with an approved cleaner.
- Check the indoor air filter and replace it if necessary.
- Check all electrical connections and tighten as necessary. Replace any connections that may be damaged
- Check the refrigerant charge before the start of the cooling season using the UI.
- The outdoor coil thermistor should be checked to insure that it is making proper contact with the tube it is mounted on.
- The suction line thermistor should also be checked to ensure that it is attached to the curvature of the suction line and tightly secured with a black wire tie.
- Check all refrigerant joints and valves for leaks. Repair using standard refrigerant procedures as necessary.
- Check both the indoor air and outdoor air fans and motors for proper operation. Clean the indoor blower wheel if dirt is building up on the blades. Fan motors are permanently lubricated, so lubrication should not be necessary for the life of the motor.
- Check the condition of the outdoor fan blades and that the fan is securely fastened to the motor shaft.
- Check that the indoor coil drain pan is clean and that the condensate flows freely through the trap.
- Check the indoor evaporator coil for build-up of dirt or mold. Clean with a proper coil cleaner if necessary. If dirt or mold is seen on the indoor coil, it may also be on the condensate drain pan and within the condensate trap. A thorough cleaning of all of these components will be necessary.
- The pressure drop across the filter-drier should be checked, especially after three months of operation following initial start-up. If pressure taps are not available to check the pressures, the temperature of the liquid line just before and right after the filter-drier can be used. If the difference between the inlet temperature and the outlet temperature exceeds 5°F, the filter-drier should be replaced.

- These units do not use a conventional crankcase heater but rather current flow through the compressor. To check operation the internal heaters use the following procedure. Since the compressor winding that is energized serves as the heat source to the compressor, so it cannot be checked like a conventional crankcase heater. Additionally, the heat will only be turned on when the compressor is determined to be the cold spot of the system. This is done by comparing the indoor air temperature at the UI and adding 40°F to it, then taking the outdoor air temperature and adding 25°F to it. If the outdoor air temperature is 55°F and the indoor air temperature is 70°F the board will compare 80°F (55° + 25°) to 110°F (70° + 40°), indicating that the compressor is the coldest spot and turn the heater on. If the compressor has been off and allowed to stabilize to the outdoor ambient temperature at these conditions, the heater should be on. The heater can be checked by touching the upper part of the compressor and working your hand down to the base, the base should feel warmer than the upper portion of the compressor. Care should be taken by moving the hands slowly to prevent burns should the compressor heat be excessive.

Cleaning the Condenser Coil

1. Use vacuum cleaner or soft bristle brush
2. Wash using water rinse
3. Use environmentally sound cleaners
4. DO NOT use harmful chemicals
5. Rinse coils regularly in coastal locations

The condition of the outdoor coil is vital to the life expectancy and operational efficiency of the unit. Elimination of contamination and removal of harmful residues will greatly increase the life of the coil and extend the life of the unit. In addition, nuisance faults may occur if the outdoor coil becomes blocked with dirt or debris. These air conditioning and heat pump units use a one-row formed condenser coil. To clean the coil, remove the louvered panels protecting the coils. Remove the outdoor fan motor from the top cover. First, vacuum the coils to remove lose dust and fibers, and then wash the coil from the inside to the outside to remove contamination and harmful residue. Do not use harmful chemicals or high pressure sprays which may damage the coil. In coastal areas the coils should be washed more frequently.

Troubleshooting

In the Troubleshooting section, we will cover the variable speed drive, followed by troubleshooting some of the components utilized in the equipment. In variable speed drive (VSD) troubleshooting we will cover the faults that may be seen and describe the causes that would have provoked the faults. Rather than troubleshooting the VSD itself, in all likelihood, we will find that the VSD is simply doing what it was designed to do. We have utilized some new components in this system, with which some technicians may not have working experience. We will cover the manner in which these components operate and what to look for to determine whether the component is operating properly or improperly.

Unit Fault Codes

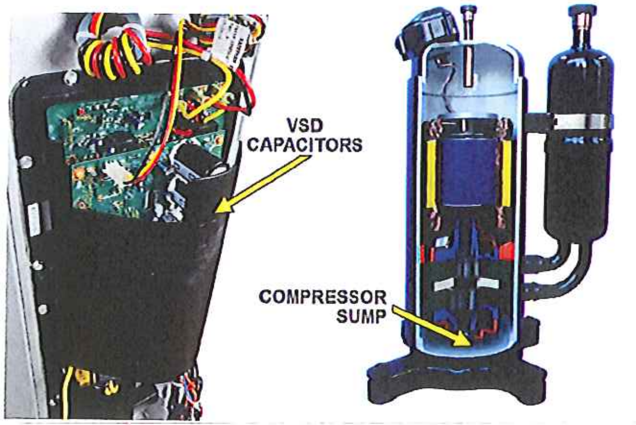
Unit Fault Codes Table

Fault	Flash Code	Type	Reset Time
Standby	ON, no flash		
Variable Capacity	1, pause		
Variable Capacity (Range Cutback)	1 (1 sec ON), longer pause (2 second OFF)		
COMMUNICATION LOSS	15	F	NA
INVALID MODEL	25	S	NA
HIGH PRESSURE SWITCH OPEN	31	E	15 Minutes
LOW PRESSURE TRIP	32	E	15 Minutes
CONTROL FAULT	45	S	NA
BROWNOUT EVENT	46	E	Revert to 5 min cycle delay
LOST INVERTER COMMUNICATIONS	48	S	Revert to 5 min cycle delay
230VAC DROPOUT-RESET EVENT	49	F	Revert to 5 min cycle delay
OUTDOOR DISCHARGE TEMP SENSOR FAULT	52	F	NA
OUTDOOR AIR TEMP SENSOR FAULT	53	F	NA
SUCTION TEMP SENSOR FAULT	54	F	15 Minutes
COIL TEMP SENSOR FAULT	55	F	NA
OAT-OCT THERMISTOR OUT OF RANGE	56	E	NA
SUCTION PRESSURE SENSOR FAULT	57	F	15 Minutes
SUCTION THERMISTOR RANGE FAULT	58	F	5 Minutes
DISCHARGE TEMP OUT OF RANGE EVENT	[illegible]	E	15 Minutes

When troubleshooting, refer to the Unit Fault Codes Table in Appendix A. Fault code detection and diagnostics is provided through AOC fault codes passed back to the user interface with the description, recording the last ten events with the date, time and frequency. These fault codes are also listed in the Installation Instructions for these products. The AOC board contains a green LED for communications and an amber LED used to display the operation mode and the fault codes. A single, active, highest priority fault code is displayed on the AOC board. However, the UI will retain the last ten system faults in its memory and can be viewed through the UI.

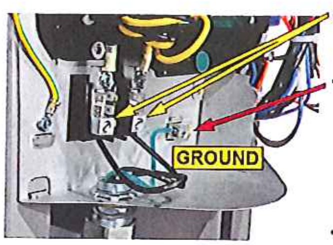
A log of faults contained within the UI can serve as a historical tracking of recurring problems. It should be understood, however, that not all recorded events represent system problems. Thus, fault codes should be used as a clue to guide the technician to the appropriate malfunctioning part of the system.

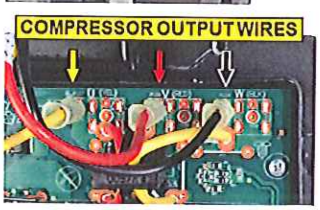
Cold Ambient Extended Standby



A standby mode such as this is not a fault mode. It is merely a notification of a present mode, which is a delay in operation that is required for reliability of the equipment. When "Compressor Sump Heating Active" is in effect, the control will flash sequence 6 then 8 on the AOC board during the 2-hour warm-up period. This was described in the earlier compressor section for crankcase heater operation.

Mis-Wire Protection



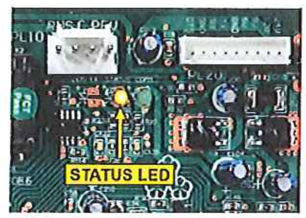


Swapping the L1 and L2 drive input power will have no effect on the operation of the VSD. However, if either L1 or L2 is swapped with the ground wire, the VSD will be damaged. Because of the fact that the VSD output is a 3-phase voltage, swapping the compressor power leads will cause the compressor to operate backwards. Running compressors backwards will result in an 81 as well as possibly a 69, 77, 89, or 98 fault codes. Refer to fault code table for description of these codes. If any one or all of these fault codes is/are displayed, please verify the following steps in the order shown until the cause is discovered and verified to have been resolved:

1. Verify that the compressor output wire harness lead colors for U, V, and W connections on the inverter match the silkscreened color indicator labels marked on the inverter and that the connections are secure.
2. Verify that the other end of the compressor output wire harness Yellow color (U) lead is connected to the compressor terminal marked (R), Red color (V) lead is connected to the compressor terminal marked (S), and the Black color (W) lead is connected to the compressor terminal marked (C). Also verify that all connections are secure and check the integrity of the terminal attachment to the individual leads.
3. Run a continuity test on the leads to check for broken or chafed leads.

Besides fault codes, mis-wired compressors will display abnormal chattering noise and will not generate a pressure differential at the service valves. Continuous operation of a 3-phase compressor in reverse rotation may cause permanent damage to the compressor.

Low Pressure Event & Lockout (32 & 83)



• 3 Flashes then 2 Flashes (EVENT)

• 8 Flashes then 3 Flashes (SYSTEM MALFUNCTION)

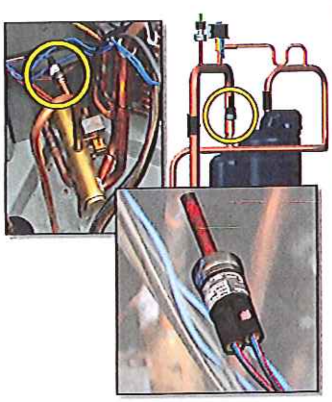
A suction pressure trip occurs when the suction pressure drops to 33 psig or below and remains there for a length of 5 minutes. It can also happen if the suction pressure drops to 15 psig or lower for any length of time. When this occurs, the compressor operation stops and a sequential flash code of 3 and 2 will be displayed. The operation will return after 15 minutes, provided the condition is favorable. If the suction pressure trip repeats 3 consecutive times a Low Pressure Lockout will result that will remain in effect for 4 hours. This will be displayed with a flash code 83 on the AOC board with a sequence of 8 and 3 and will automatically reset in 4 hours.

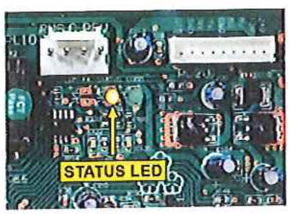
Check for loss of refrigerant charge by verifying the high and low side pressures against the charging chart in cooling or the heating check chart in heating modes. Make sure that you charge by weigh-in method while in heating mode or outside of the acceptable conditions while charging in cooling mode.

A low suction pressure condition can also occur due to frost build up on the evaporator coil. In heating mode, check to make sure the outdoor coil is not blocked and is reasonably clean. Also in heating, make sure that the outdoor fan is operating properly and that the fan blade is not damaged. In cooling mode, especially with a non-communicating indoor unit, make sure that the indoor blower is operating properly and the duct system is not unduly restricted.

Also, proper expansion device operation is very important to maintaining the proper suction pressure. See troubleshooting section for the EXV (heating) and TXV (in cooling).

High Pressure Event and Lockout (31 & 84)



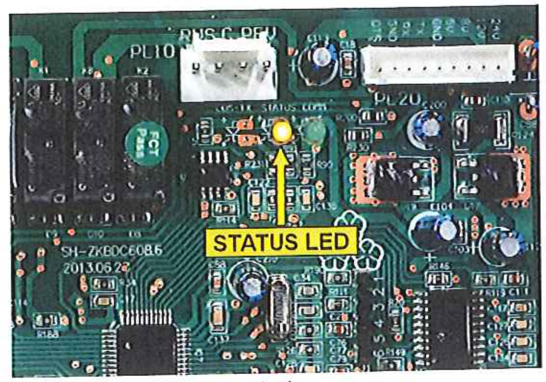


- 3 Flashes then 1 Flash (EVENT)
- 8 Flashes the 4 Flashes (SYSTEM MALFUNCTION)

If the AOC board senses that the high-pressure switch has opened, it will stop the compressor operation and the display will flash sequence 3 then 1 on the AOC board.

After 15 minutes, if the high-pressure switch has closed and if there is a call for heating or cooling, the compressor will energize. If the high-pressure switch has not closed, the outdoor fan motor will be turned off. If the open high-pressure switch closes any time after the 15-minute delay, the unit will resume a staged down (one stage) operation with a call for cooling or heating. If upon staging down the fault reappears, or if the high-pressure switch trips three consecutive cycles, the operation of the unit will be locked out for 4 hours. In the event of a high-pressure switch trip or high-pressure switch lockout the display will flash sequence 8 then 4 on the AOC board. Check the refrigerant charge and check the outdoor fan motor operation. Keep in mind that the outdoor fan motor may work properly until it heats up. Check the outdoor coil in cooling for airflow restrictions and the indoor airflow in heating for airflow restrictions.

Brownout Protection (46)



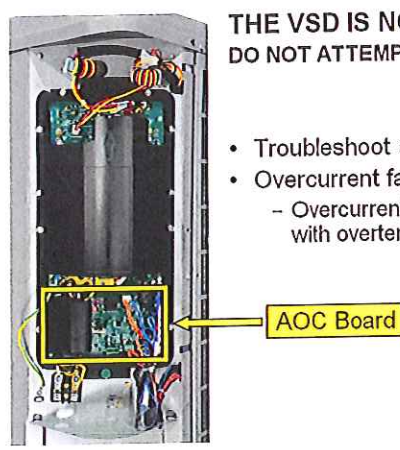
- 4 Flashes then 6 Flashes (EVENT)

If the brownout feature is not turned off, and if the line voltage is less than 197 volts for at least 4 seconds, the compressor contactor and fan operation are de-energized and the AOC board display will flash sequence 4 then 6 on the AOC board.

The compressor and fan operation will not be allowed to turn on until the line voltage is a minimum of 190 volts. There will be a 5-minute time delay to start cooling operation when there is a call from the UI or when the unit returns from a brownout condition. This can be bypassed by momentarily shorting the Forced Defrost pins.

The brownout feature can be defeated, if needed, for severe noisy power conditions. This defeat should always be a last resort to solving the problem. The defeat is available on the UI SETUP menu.

Troubleshooting the VSD



THE VSD IS NON-SERVICEABLE
DO NOT ATTEMPT TO REMOVE COVER

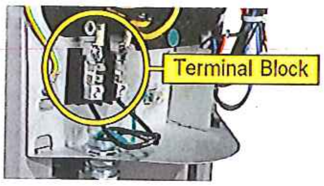
- Troubleshoot applications
- Overcurrent faults are most common
  - Overcurrent faults go hand-in-hand with overtemperature faults

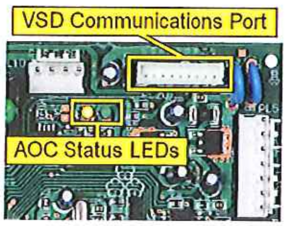
As mentioned earlier in this program, if the system appears to be having VSD problems, rather than troubleshooting the VSD, troubleshoot the VSD application. The application is everything surrounding the VSD.

Overcurrent faults are the most common fault that will shut down a VSD and overcurrent faults go hand-in-hand with overtemperature faults. Finding the actual problem is the challenge. A drive shutdown is usually caused by external conditions.

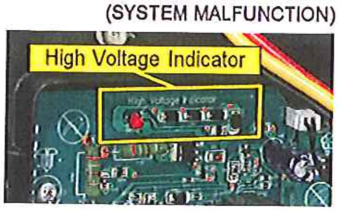
Recordings of VSD line voltage, motor currents, and temperature readings of the heat sink can track the health of the VSD over its life and even provide an indication of an upcoming problem.

Lost Inverter Communication (48)





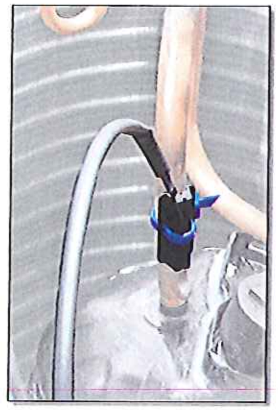
- 4 Flashes then 8 Flashes (SYSTEM MALFUNCTION)

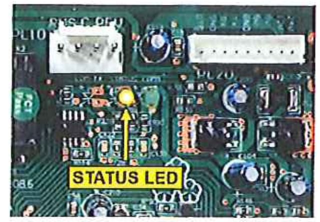


If the Lost Inverter Communications fault is present (code 48), the LEDs will flash sequence 4 then 8 on the AOC board. With the service panel removed from unit and high voltage connected: (Note: DO NOT attempt to remove the black plastic cover).

1. Verify Fault code LED is blinking 48 on AOC board.
2. Check for 197 to 253V AC at terminal block (input to VSD).
3. Check that the red LED is lit (high voltage indicator) at the top left side of VSD.
4. Remove high voltage from unit and verify VSD communication port cable is securely seated in socket at both ends.
5. Reapply power to outdoor unit and call for demand using Infinity® User Interface or thermostat.
6. Verify unit operation.
7. If the fault reappears, replace VSD.

Discharge Temperature Fault and Lockout (59 Event & 74 Lockout)

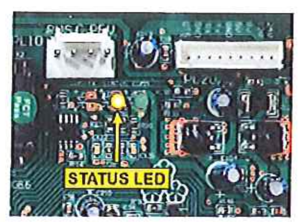




- 5 Flashes then 9 Flashes (EVENT)
- 7 Flashes then 4 Flashes (SYSTEM MALFUNCTION)

A discharge temperature fault will be displayed with a flash code 59 on the AOC board with a sequence of 5 and 9 and will automatically reset in 15 minutes. A discharge temperature event can result from a number of abnormal operational situations such as significant refrigerant undercharge, oil or refrigerant contamination or moisture in the system, poor operation of an expansion device, plugged circuit, or distributor feeder tube. Following each such event, a stage down will result as the system tries to protect the compressor, and if the event reappears, it will continue staging down until it occurs at the lowest stage of operation allowed at that ambient condition. If that happens a lockout fault code 74 will result with a sequence of 7 and 4 and will automatically reset in 2 hours.

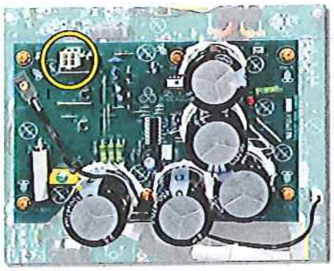
Fan Inverter Temperature High (62 Event & 85 Lockout)

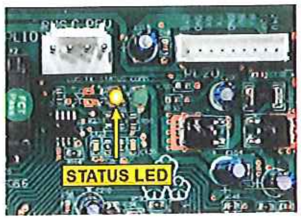


- 6 Flashes then 2 Flashes (FAULT)
- 8 Flashes then 5 Flashes (SYSTEM MALFUNCTION)

Overtemperature faults can appear on the Fan Inverter and are usually attributable to improper airflow across the VSD heat sink located in the compressor compartment on the backside of the inverter. An overtemperature event will be the result with the AOC board flash code 62, which is a display of a sequence of 6 and 2 and the operation will be interrupted for 15 minutes. However, after 3 such events an overcurrent lockout will occur with a display of flash code 85 which is a sequence of 8 then 5 on the AOC board. A lockout occurs when the fan inverter recognizes an over- temperature condition and will lock out the VSD. This malfunction will automatically reset in 4 hours.

Fan Inverter Current (63 Event and 86 Lockout)

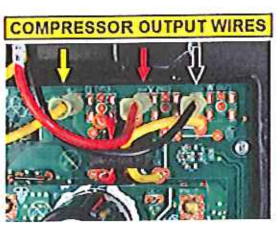


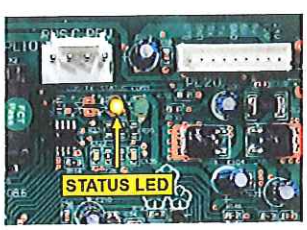


- 6 Flashes then 3 Flashes (FAULT)
- 8 Flashes then 6 Flashes (SYSTEM MALFUNCTION)

The high fan current lockout occurs when the current supplied to the fan motor reaches a reliable operational limit. The fan motor will be shut down and will be accompanied by a fault indication. Generally, this happens when a sudden voltage supply change occurs or a sudden load change from the fan/motor takes place. An overcurrent event will be the result with the AOC board flash code 63 which is a display of a sequence of 6 and 3 and will automatically reset in 5 minutes. After 3 such events a Fan Inverter Current Lockout will occur with a display of flash code 86, which is a sequence of 8 then 6 on the AOC board and will automatically reset in 15 minutes. This lockout occurs when the VSD recognizes a repeating overcurrent condition and will lock out the VSD. Verify that the VSD is operating within the specified envelope.

Inverter/Compressor Internal Fault (69)





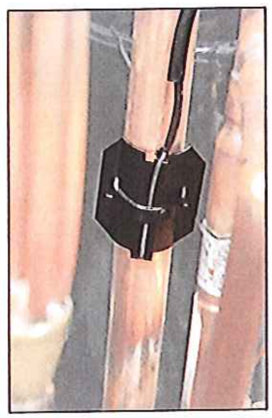
- 6 Flashes then 9 Flashes (SYSTEM MALFUNCTION)

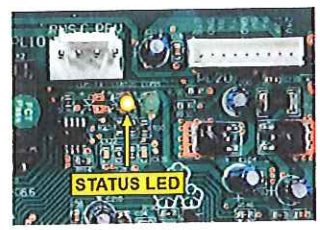
An inverter/compressor internal fault will be displayed with a flash code 69 on the AOC board with a sequence of 6 and 9 and will automatically reset in 15 minutes. This fault normally results from a starting issue. When this happens, the first thing to check is for a possible phase imbalance due to a compressor wire harness mis-wire either at the compressor terminals or at the inverter U, V and W terminals. Refer to mis-wire section.

If the phase imbalance was not the reason, then proceed to check for a flooded starting situation. Flooded start can happen due to expansion device malfunction. Troubleshoot the expansion device.

Another possibility is if the system is overcharged. Verify that the system is properly charged.

Suction Overtemperature Event and Lockout (72 Event & 82 Lockout)





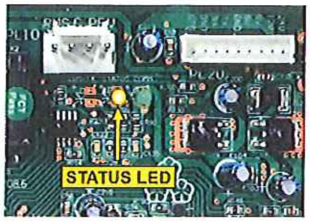
- 7 Flashes then 2 Flashes (FAULT)
- 8 Flashes then 2 Flashes (SYSTEM MALFUNCTION)

A suction temperature fault will be displayed with a flash code 72 on the AOC board with a sequence of 7 and 2 and will automatically reset in 15 minutes. A Suction Overtemperature event code will appear when the current suction temperature reaches abnormal level. This event will clear after 15 minutes of operation in this condition. Possible causes are as follows:

1. Incorrect refrigerant charge.
2. Uninsulated vapor lines.
3. Indoor TXV improper operation in cooling mode.
4. Outdoor EXV improper operation in heating mode.
5. Reversing valve bypass.

If the condition persists a lockout fault code 82 will result with a sequence of 8 and 2 and will automatically reset in 4 hours.

Inverter Overcurrent (77 Event & 95 Lockout)



- 7 Flashes then 7 Flashes (EVENT)
- 9 Flashes then 5 Flashes (SYSTEM MALFUNCTION)

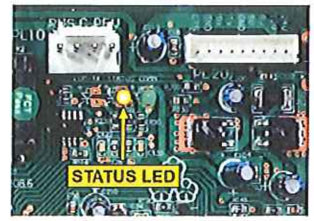
An overcurrent event will be displayed with a flash code 77 on the AOC board with a sequence of 7 and 7. The overcurrent event usually occurs when the compressor is operating outside of the design envelope for a given speed. If this happens, the inverter may shed the load by reducing the speed to protect the compressor and the inverter. After 15 minutes of operation at this speed-reduced condition, the system will stage down to a lower stage of operation, and if a similar condition persists, it may repeat at a lowered stage. Thus, stage down may continue to one even lower stage until the lowest stage allowed for that ambient. If this overcurrent condition exists during operation at the lowest stage, the operation will be stopped and a lock-out fault code 95 will be displayed on the AOC board with a sequence of 9 and 5. The inverter overcurrent fault 95 is considered a malfunction and the lock-out will automatically reset in 2 hours.

Check and monitor the suction and discharge pressures to ensure that they look normal for the conditions present. Check the refrigerant charge to make sure that the system is charged properly. Also check to make sure the condenser coil is reasonably clean and the fan or the blower is properly functioning.

Never rule out the incoming power voltage, making sure that it is within the operating envelope of the unit. If there is reason to believe that the incoming voltage is outside of the specified operating range, make a request to the local utility to place a voltage monitor on the incoming lines.

Check for loose or incorrect wire connections between the incoming power leads and outgoing power leads to the compressor's molded plug.

Inverter Temperature (75 Event & 88 Lockout)



- 7 Flashes then 5 Flashes (EVENT)
- 8 Flashes then 8 Flashes (SYSTEM MALFUNCTION)

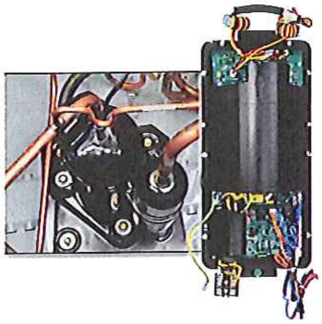
Overtemperature event or fault can be the result of the Inverter PFC module overheating, which sometimes could be attributable to improper airflow across the VSD heat sink located in the compressor compartment on the backside of the inverter. An overtemperature event will be displayed with an AOC board flash code 75 which is a display of a sequence of 7 and 5 and the operation will be modified to self-protect the inverter as a result by reducing the speed in proportion to the severity of the overtemperature. If this condition persists for longer than 15 minutes, it will stage down to the next lower stage in order to protect the inverter. If after repeating such stage downs to the lowest stage allowed, due to repeated over temperature conditions, the operation will stop, and will display a 4-hour lock-out fault code 88, which is a sequence of 8 then 8 on the AOC board. This malfunction will automatically reset in 4 hours.

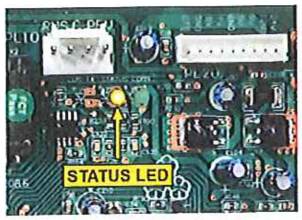
Check to make sure that the heat sink fins are not blocked with dirt or debris. If it is, remove any dirt and debris that may be restricting the airflow.

Ensure that the outdoor fan motor is operating properly and air is actually being drawn over the VSD heat exchanger fins and make sure that something did not change, causing the airflow to bypass the heat sink. Also, check the outdoor fan blade to make sure that it was not replaced with an improper fan blade.

Check to make sure that the suction and discharge pressures are correct for the conditions that the unit is operating. Also ensure that the condition that the unit is running at is within the design specifications. Check the refrigerant charge to make sure that it contains the proper amount of charge. If there is reason to believe that the incoming voltage is outside of the specified operating range, make a request to the local utility to place a voltage monitor on the incoming lines. If the fault did not result due to any of the above likely problems, it could be an indication of a VSD malfunction.

Compressor/Inverter PFC Major Fault (81)

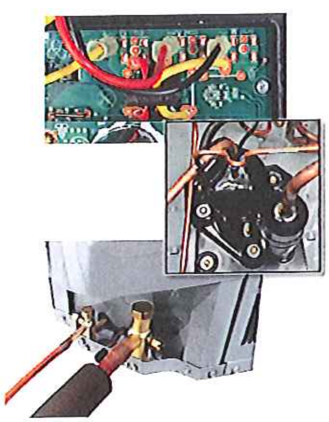


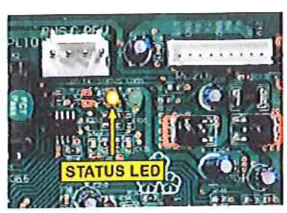


- 8 Flashes then 1 Flashes (SYSTEM MALFUNCTION)

A compressor/inverter PFC major fault will be displayed with a flash code 81 on the AOC board with a sequence of 8 and 1 and will automatically reset in 15 minutes. This fault could be the result of a compressor to the inverter mis-wire. Refer to mis-wire section.

Inverter VDC-Out Overvoltage (91)

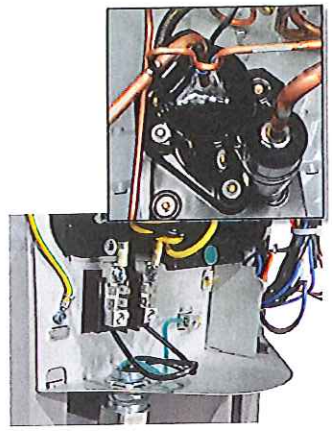


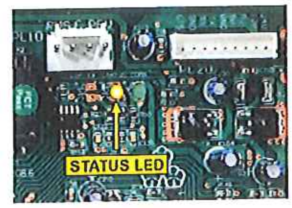


- 9 Flashes then 1 Flash (EVENT)

The overvoltage fault occurs when the bus voltage supplied to the compressor motor exceeds 410 VDC, shutting down the compressor. Generally, this happens when the compressor is suddenly unloaded. If this occurs, check that the service valves are fully open. If the valves are fully open, then troubleshoot the compressor. The VSD overvoltage fault is considered an event which will flash sequence 9 then 1 on the AOC board, and will automatically reset in 15 minutes. If the valves are fully open, and the compressor is operating properly and the fault repeats, it is possible that the VSD may have a malfunction.

Inverter VDC-Out Undervoltage (92)





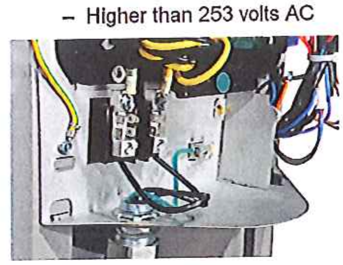
- 9 Flashes then 2 Flashes (EVENT)

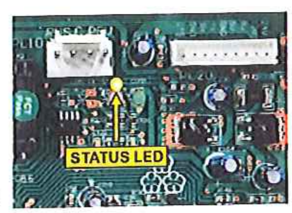
The undervoltage fault occurs when the bus voltage supplied to the compressor motor falls below 220 VDC, shutting down the compressor. Generally, this happens when there is an interruption to the main voltage. If this occurs on multiple occasions, ask the local utility to install a voltage monitor on the incoming power line.

The VSD undervoltage fault is considered an event, and will flash sequence 9 then 2 on the AOC board, and will automatically reset in 15 minutes.

AC Over/Undervoltage (93 or 94)

INCOMING VOLTAGE TO VSD
- Lower than 197 volts AC
- Higher than 253 volts AC





- 9 Flashes then 3 Flashes (UNDERVOLTAGE EVENT)
- 9 Flashes then 4 Flashes (OVERVOLTAGE EVENT)

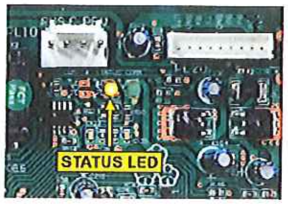
The AC over/under voltage fault occurs when the incoming voltage supplied to the VSD is lower than 197 volts AC or higher than 253 volts AC. If this occurs on multiple occasions, make a request to the local utility to place a voltage monitor on the incoming lines.

The AC over/under voltage fault is considered an event, and will flash sequence 9 then 3 on the AOC board for under voltage or will flash sequence 9 then 4 on the AOC board for overvoltage, and will automatically reset in 15 minutes.

DC Output Voltage Lockout (96 or 97)

VSD VOLTAGE SUPPLIED TO THE COMPRESSOR IS:

- Lower than predetermined low limit
- Higher than predetermined high limit

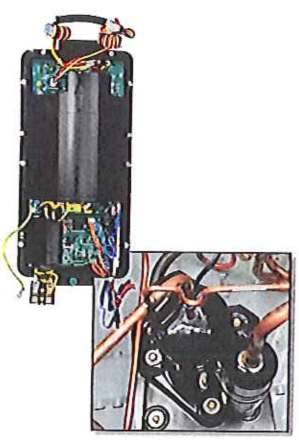


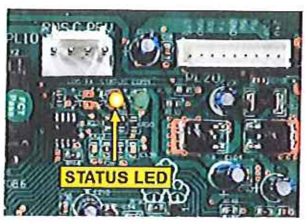
- 9 Flashes then 6 Flashes (UNDERVOLTAGE MALFUNCTION)
- 9 Flashes then 7 Flashes (OVERVOLTAGE MALFUNCTION)

The DC output voltage lockout occurs when the VSD voltage supplied to the compressor motor is lower than a predetermined low limit or higher than a predetermined high limit. If this occurs on multiple occasions, make a request to the local utility to place a voltage monitor on the incoming lines.

The VSD DC output voltage fault is considered a malfunction and will flash sequence 9 then 6 on the AOC board for under voltage or will flash sequence 9 then 7 on the AOC board for overvoltage, and will automatically reset in 2 hours.

High Torque Event (98) and Lockout (99)





- 9 Flashes then 8 Flashes (EVENT)
- 9 Flashes then 9 Flashes (SYSTEM MALFUNCTION)

A high torque event will be displayed with a flash code 98 on the AOC board with a sequence of 9 and 8 and will automatically reset in 10 minutes. The high torque event usually occurs when the compressor is operating outside of the system design envelope for a given speed. If this happens the inverter may shed the load by reducing the speed to protect the compressor. After 10 minutes of operation at this speed-reduced condition, the system will stage down to a lower stage of operation, and if a similar condition persists, it may repeat at a lowered stage. Thus, stage down may continue to one even lower stage until the lowest stage allowed for that ambient. If this over torque condition exists during operation at the lowest stage, the operation will be stopped and a lock-out fault code 99 will be displayed on the AOC board with a sequence of 9 and 9. The over torque fault 99 is considered a malfunction and the lock-out will automatically reset in 15 minutes.

Check and monitor the suction and discharge pressures to ensure that they look normal for the conditions present. Check the refrigerant charge to make sure that the system is charged properly. Also check to make sure the condenser heat exchanger is reasonably clean and that the condenser fan or the blower is properly functioning. When checking the outdoor fan blade, make sure that it was not replaced with an improper fan blade. It is possible that a condenser coil circuit is malfunctioning due to pinched or blocked circuit to cause this fault. Also, follow the expansion device troubleshooting procedure for the TXV in cooling mode and the EXV in heating mode if an expansion device problem is suspected.

Component Troubleshooting

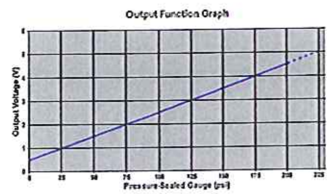
Compressor Troubleshooting

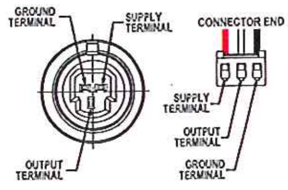
ROTARY COMPRESSOR

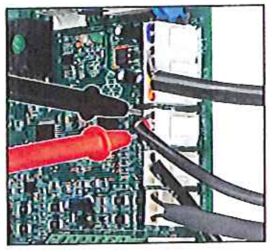
- Sensitive to dirt, debris, moisture, and contaminants due to design:
  - Very tight clearances
  - Vanes that operate at very high temperatures
- Additional protection and precautions are required compared to other types of compressors

The rotary compressor used in this system is sensitive to dirt, debris, moisture and contaminants more than any other type of compressor due to its design, with very tight clearances, and vanes that operate at very high temperature. Therefore, in comparison to other type of compressors, additional protection and precautions are required for long term reliability. Failing to provide this can result in problems that could generate a fault code indicating the protection mode. To determine the possible problem see the fault code table located in the Installation and Service Book or the label on the unit.

Pressure Transducer Troubleshooting







GROUND AND SUPPLY TERMINAL

If the accuracy of the transducer is questioned, the technician can check it while it is attached to the AOC board. Connect a gage manifold to the suction valve gage port fitting.

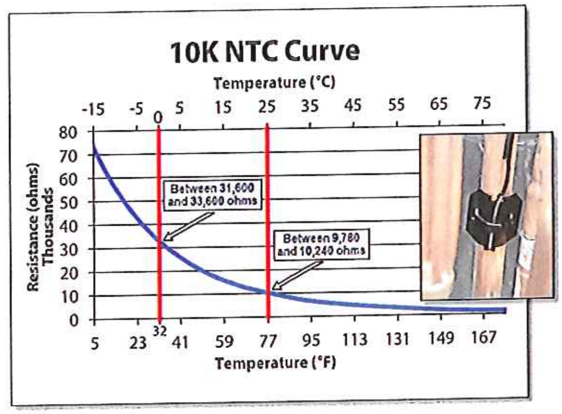
At the AOC board, with the wire harness receptacle exposing a portion of the three pins on the AOC board, a DC voltmeter can read the DC voltage between ground and the supply (input) terminal. Ensure that the input voltage is 5 VDC. Next, read the DC voltage across the ground and output terminal. Record the output voltage.

The suction pressure that the pressure transducer is reading can be calculated by taking the output voltage and subtracting 0.5 from it, then taking that difference and multiplying it by 50. Pressure (psig) = 50.0 x (DCVout - 0.5). For example, if the measured voltage is 3.0 VDC: 50 x (3.0 - 0.5) = 50 x 2.5 = 125 psig.

This can then be compared to the actual suction pressure from the gage manifold. In the event of a low pressure trip or low pressure lockout, check the refrigerant for an undercharge. If the charge is found to be correct, check for low indoor airflow in cooling.

On heat pump units in heating check the outdoor fan for proper operation and outdoor coil for airflow restrictions. Keep in mind that the outdoor fan motor may run normally until it heats up.

Suction Thermistor Troubleshooting

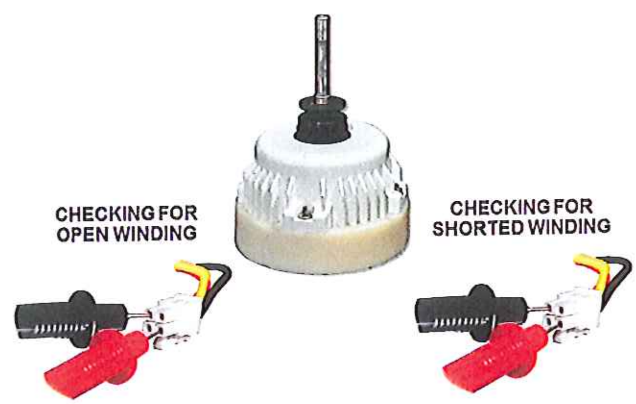


If for some reason it appears that the suction line thermistor is not operating properly, the first thing that should be checked is the mounting on the suction line. The suction line thermistor is designed to be secured to a 5/8 or 3/4-inch diameter refrigerant line aligned longitudinally. The thermistor must also be secured tight on the line with the curved surface hugging the pipe surface. A black UV resistant wire tie is routed through the slot in the insulating plastic body to tightly attach the thermistor to the suction line to minimize the influence of the ambient temperature.

The thermistor wire leads should be checked for nicks, cuts or breaks as well as the connections at the AOC board.

The resistance of the thermistor can also be checked, first by placing the thermistor in an ice bath. The resistance should be between 31,600 and 33,600 ohms. A second measurement at 77° F can be made and the resistance values should be between 9,780 and 10,240 ohms.

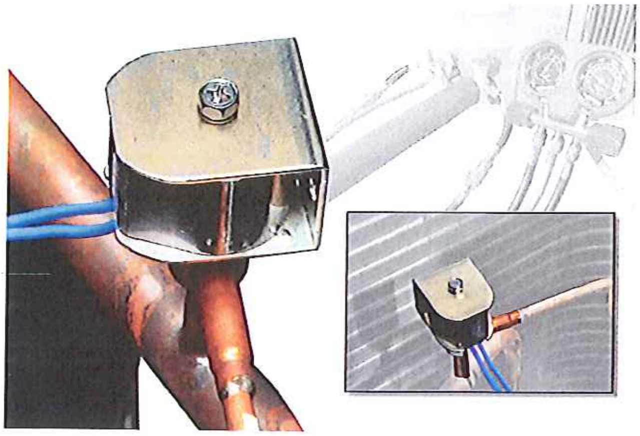
Outdoor Fan Motor Troubleshooting



At fan motor startup, the fan blade will rotate backwards in a quick, cogging motion. This allows the inverter to determine the rotor position which is needed to operate the motor at the required variable speeds.

Checking the motor can be accomplished with a volt-ohm-meter (VOM). Set the scale on R x 1 ohm position and check for continuity between the three power terminals. An open circuit is an indication of a failed motor. Replace the motor if it shows signs of arcing, burning or overheating on wire leads. If the motor shaft is hard to turn, it could be due to internal damage.

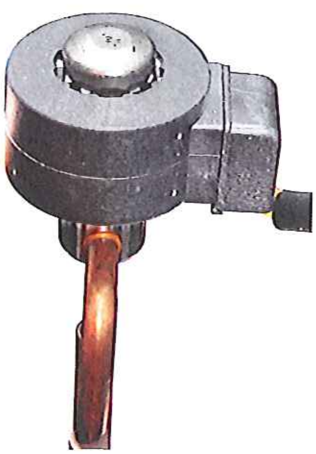
PEV Troubleshooting



The PEV ensures that the rotary compressor is not exposed to high differential pressure at startup. If the PEV has failed, the compressor may fail to start due to a high pressure differential condition. Use a gage set to check for equalized pressures at service valves before unit startup. Once the thermostat or UI creates a demand for heating or cooling, the PEV should open for 90 seconds before the compressor starts. If pressures do not equalize before the compressor attempts to start, the PEV solenoid or a restriction in the PEV orifice could be the cause. Check the solenoid coil for open, shorted, or grounded resistance measurement. Replace if necessary. A PEV coil operates with 24V DC signal from AOC board RVS/PEV plug.

EXV Troubleshooting (Heat Pump Only)

- Check first that plastic cap is firmly attached to the top of the EXV brass body
- EXV solenoid coil's electrical resistance should be between 45 and 55 ohms



The EXV assembly consists of two components, the EXV brass body valve containing the stepper motor, and the EXV black plastic cap that houses the solenoid coil to energize the stepper motor inside of the valve. Always check first that this black plastic cap is firmly attached to the top of the EXV metal body and the latch is engaged underneath the plastic body.

Utilizing the CHECKOUT feature of the UI, the EXV can be driven open or closed. Stepper motors exhibit a slight audible noise as the discrete step tends to snap the rotor from one position to another, causing a vibration. This vibration can be heard by ear and felt by hand on the valve. This vibration indicates electrical viability, but not 100% of the time. The movement may be heard and felt but the valve may not be opening and closing. This is because the stepper motor rotor may be stuck or the rotor is skipping steps. This will require testing of the EXV.

To test the EXV for movement and operation, with the unit off, close the EXV with the UI. Next, remove the EXV coil connector from the AOC board and turn the unit on in the heating mode. Since the EXV is supposed to be closed, the refrigerant will be pumped into the indoor coil, possibly cycling on the low pressure protection. If any of this does not occur, the EXV is not closed.

With the EXV operating properly and closed, after the unit is pumped down and stopped, reinstall the EXV coil connector to the AOC board and open the EXV using the UI. Reset any error codes that may have been created. Then operate the unit in the heating mode to confirm that the valve is open. If the unit will not operate, the valve is still closed.

Before condemning the valve, check the wire leads to the EXV coil and the plastic cap on the EXV body. Check the wire connections on the AOC board and at the coil. Check along the length of wire as well for nicks, cuts or breaks.

If during the EXV test the valve appears to move but does not open or close completely, try flushing the valve by opening the valve and operating the unit in the cooling mode in an attempt to flush any debris out of the valve. Then repeat the test to ensure that the valve opens and closes fully.

Skill Check

This completes our training on the 24VNA9 air conditioner and 25VNA8 heat pump. With the information in this program, the installation instructions and the service manual you should be able to install and service this product with confidence. If you have additional concerns about the use of the UI a separate training program is available on the Infinity® Touch Control.

Now to make sure you have mastered the material in this training take the skill check quiz located after the appendix. The answers are located at the end of the book.

Appendix A – Unit Fault Codes Table

FAULT	FLASH CODE	TYPE	RESET TIME
STANDBY	ON, no flash		
VARIABLE CAPACITY	1, pause		
VARIABLE CAPACITY (RANGE CUTBACK)	1 (1 sec ON), longer pause (2 second OFF)		
COMMUNICATION LOSS	16	F	NA
INVALID MODEL	25	S	NA
HIGH PRESSURE SWITCH OPEN	31	E	15 Minutes
LOW PRESSURE TRIP	32	E	15 Minutes
CONTROL FAULT	45	S	NA
BROWNOUT EVENT	46	E	Revert to 5 min cycle delay
LOST INVERTER COMMUNICATIONS	48	S	Revert to 5 min cycle delay
230VAC DROPOUT-RESET EVENT	49	F	Revert to 5 min cycle delay
OUTDOOR DISCHARGE TEMP SENSOR FAULT	52	F	NA
OUTDOOR AIR TEMP SENSOR FAULT	53	F	NA
SUCTION TEMP SENSOR FAULT	54	F	15 Minutes
COIL TEMP SENSOR FAULT	55	F	NA
OAT-OCT THERMISTOR OUT OF RANGE	56	E	NA
SUCTION PRESSURE SENSOR FAULT	57	F	15 Minutes
SUCTION THERMISTOR RANGE FAULT	58	F	5 Minutes
DISCHARGE TEMP OUT OF RANGE EVENT	59	E	15 Minutes
FAN INVERTER TEMPERATURE HIGH	62	F	15 Minutes
FAN INVERTER OVER CURRENT	63	F	5 Minutes
DC VOLTS LOW FAULT	65	F	5 Minutes
OUTDOOR FAN DROPPED OUT	66	F	5 Minutes
STATOR HEATER FAULT	67	F	5 Minutes
COMPRESSOR SUMP HEATING ACTIVE	68	E	2 Hours
INVERTER/COMPRESSOR INTERNAL FAULT	69	S	15 Minutes
COMPRESSOR DROPPED OUT	71	F	5 Minutes
SUCTION OVER TEMP EVENT	72	F	15 Minutes
FAN INVERTER LOCKOUT	73	S	15 Minutes
DISCHARGE TEMP OUT OF RANGE LOCKOUT	74	S	2 Hours
INVERTER TEMP EVENT	75	E	15 Minutes
FAN INVERTER FAULT FROM MOC	76	S	15 Minutes
INVERTER OVER CURRENT EVENT	77	E	15 Minutes
COMP INVERTER PFC MAJOR FAULT	81	S	15 Minutes
SUCTION OVER TEMP LOCKOUT	82	S	4 Hours
LOW PRESSURE LOCKOUT 4 HOURS	83	S	4 Hours
HIGH PRESSURE LOCKOUT 4 HOURS	84	S	4 Hours

FAULT	FLASH CODE	TYPE	RESET TIME
FAN INVERTER TEMP LOCKOUT	85	S	4 Hours
FAN INVERTER CURRENT LOCKOUT	86	S	15 minutes
INVERTER TEMP LOCKOUT	88	S	4 Hours
COMP INVERTER OVER CURRENT LOCKOUT	89	S	15 Minutes
INVERTER VDC-OUT OVER VOLTAGE EVENT	91	E	15 Minutes
INVERTER VDC-OUT UNDER VOLTAGE EVENT	92	E	15 Minutes
230VAC UNDER VOLTAGE EVENT	93	E	15 Minutes
230VAC OVER VOLTAGE EVENT	94	E	15 Minutes
HIGH CURRENT LOCKOUT	95	S	2 Hours
VDC UNDER VOLTAGE LOCKOUT	96	S	2 Hours
VDC OVER VOLTAGE LOCKOUT	97	S	2 Hours
HIGH TORQUE EVENT	98	E	10 Minutes
HIGH TORQUE LOCKOUT	99	S	15 Minutes

E = EVENT F = FAULT S = SYSTEM MALFUNCTION

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